# SCIENCE ABSTRACTS.

## Section A.—PHYSICS.

---

**JULY, 1929.**

---

## GENERAL PHYSICS.

**2046. Statistical Description of Size Properties of Non-Uniform Particulate Substances. T. Hatch and S. P. Choate.** *Frank. Inst., J.* 207. *pp.* 369–387, *March,* 1929.

Particle size in non-uniform particulate substances is defined in terms of the shape of the size-frequency curves. The asymmetric curve obtained by plotting particle size against percentage frequency of distribution of sizes is transformed into a symmetrical normal-probability curve by substituting the logarithms of the particle sizes for the sizes themselves. Theoretical reasoning shows that the size properties (number of particles per gramme and specific area of the substance) are functions of the two statistical parameters of this symmetrical log-probability curve. This method of defining particle size is preferable to one depending on the use of the diameters of the hypothetical particles having average surface area and average volume respectively, because (1) each pair of statistical curve parameters, unlike the average diameters, defines a unique size-frequency distribution curve; (2) information concerning size distribution and relative frequency of certain sizes, unobtainable from a consideration of average diameters, can be obtained from these parameters; (3) the average diameters are functions of the curve parameters, and therefore the latter can give all the information obtainable from the former; (4) the parameters can be determined graphically from the summation curves. The theoretical conclusions are confirmed by experimental observations on quartz, ground calcite and granite dust. The results show incidentally that the frequent assumption that particulate materials are spherical may be in error by a considerable amount. A. J. M.

**2047. Dines Float Barograph. L. H. G. Dines.** *Roy. Meteorolog. Soc., J.* 55. *pp.* 37–49; *Disc.,* 49–53, *Jan.,* 1929.

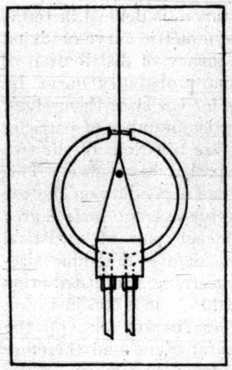
The instrument consists essentially of a syphon barometer of special form, with upper and lower reservoirs of equal diameter. The movements of the mercury in the lower reservoir, due to changes in atmospheric pressure, are communicated by means of a float to the recording pen through the intermediary of a pair of concentric pulley wheels, whereby an overall magnification of about two to one is obtained. The method of filling the instrument with mercury is described. The principal source of difficulty in the use of the instrument lies in the variation of the temperture; this is largely compensated for by a special device. The character and mode of correction for the residual errors are described in detail. A. A. D.

**2048. Errors of Inertia of Cup Anemometers with Varying Wind Strength. O. Schrenk.** *Zeits. f. techn. Physik,* 10. 2. *pp.* 57–66, 1929.

The author first discusses the kinds of errors which may occur, and then gives the results of an experimental determination of the turning moment for the rotating cups. The effect of intermittently changing wind speeds is next considered, and an estimate is made of the mean error with a periodic wind oscillation. Finally, some applications and results are examined. R. S. R.

**2049. Sublimation Mercury Still. K. Hickman.** *Kodak Research Lab., Comm. No.* 369. *J.O.S.A. and R.S.I.* 18. *pp.* 62–68, *Jan.,* 1929.

The principle of the arrangement is the sublimation of mercury into an evacuated space, thus preventing boiling or ebullition from disturbing the liquid surface. The apparatus is made up of three connected glass vessels each in the form of an alembic. The mercury in the bulb is heated externally by electrical means and condenses on the walls, whence it falls to the annulus and runs off to the collector. The three vessels are used in series and possess a capacity of 400 c.c. of mercury in 24 hours. R. S. R.



**2050. Differential Manometer for Use during Aeroplane Flights. E. Huguenard and A. Magnan.** *Comptes Rendus,* 188. *pp.* 484–487, *Feb.* 11, 1929.

Describes an instrument designed for the photographic recording of the pressure differences at selected points around an aeroplane during flight. Two Venturi or Pitot tubes are connected to the two semicircular manometer tubes shown in the figure. The difference of pressure is indicated by the movement of the vertical needle. The authors have obtained simultaneous records with (1) an accelerometer, (2) a tachometer and (3) the differential manometer. J. W. T. W.

**2051. Fused Quartz Pendulum Rod for Clocks. C. V. Boys.** *Phys. Soc., Proc.* 41. *pp.* 143–146; *Disc.,* 147–150, *Feb.,* 1929.

The author discusses the possible causes of the progressively increasing losing-rate found in the going of the Shortt clock. He shows a design for the free pendulum suitable for use where the rod is made of fused quartz. He would prefer tempered carbon steel for the supporting springs. AUTHOR.

**2052. New Apparatus for Autographic Records of the Strength and Elongation of Textile Fibres and Yarns. S. G. Barker and N. Tunstall.** *Faraday Soc., Trans.* 25. *pp.* 103–108, *March,* 1929.

The paper describes the construction of a new apparatus produced by the Cambridge Instrument Company in conjunction with the authors. A particular feature of the apparatus is that the connection between the test piece and the spiral spring used to measure the tension in it is kept sensibly at rest by causing the other ends of the test piece and the spiral spring to move outwards at appropriate speeds. The effect of temperature and of humidity on different types of fibre is being investigated. It is

desired to determine the internal structure of wool fibres, these investigations being related to the spinning, felting and other properties of fibres.
J. K.

**2053. Experiments on Vacuum Distillation. C. R. Burch.** *Roy. Soc., Proc.* 123. *pp.* 271–284, *March* 6, 1929.

This paper refers to the application of modern vacuum technique to the fractional distillation of organic substances in general and in particular to the fractionation of petroleum and its derivatives. A description of the apparatus set up in which the behaviour of organic substances heated *in vacuo* is described in detail. It is stated that derivatives of very high molecular weight can be fractionated in this way without detecting any decomposition. With regard to petroleum, decomposition (" cracking ") is found to set in quite suddenly at temperatures varying from 307° C. to 340° C. for the oils tried. By this method greases and oils have been produced having very low vapour pressures at room-temperatures which permit their use in the joints of high vacuum systems replacing mercury in condensation pumps and in the exhaustion of thermionic valves; the liquid air trap has been found to be unnecessary. J. K.

**2054. Lubricant Friction and Flow Orientation. S. Kyropoulos.** *Zeits. f. techn. Physik,* 10. 2. *pp.* 46–52, 1929.

A review and discussion of recent work on the above subject. The modification of the hydrodynamical theory of lubricant friction which is necessary to accord with experiment involves, fundamentally, molecular effects. Molecular considerations indicate that a variation of viscosity with the velocity of the moving parts (as actually observed) is characteristic of the lubrication process. Both theory and experiment show that pronounced flow orientation [see Abstract 1400 (1929)] leads to small lubricant layer thickness. Thick lubricant layers being of practical importance, the possibility of obtaining such layers by adding to the lubricant certain substances which disturb the flow orientation are discussed; the action of small additions of plant oils (in particular resin oils) in decreasing the friction are explained as arising in this way. Theory and experiment show that greatest oil-viscosity does not necessarily involve thickest lubricant layer for the range of axle speeds of practical importance. W. S. S.

**2055. Viscosity Formula for Binary Mixtures. T. Ishikawa.** *Chem. Soc. Japan, Bull.* 4. *pp.* 5–15, *Jan., and pp.* 25–31, *Feb.,* 1929.

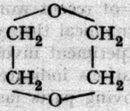
Considers different proposed viscosity formulæ. Assumes that in an associated molecule the individual molecules are not bound fast together but are subjected to an attraction field, which is proportional to the degree of association. Obtains a formula for the viscosity of binary mixtures of chemically indifferent liquids and shows that it gives satisfactory results for fifteen different pairs of liquids mixed in different proportion. In Part II the relation between the field constant $k$ and the molecular structure is considered. It is shown that $D\sigma/k$ is a constant for homologous liquids, where D is the dielectric constant ($\lambda = \infty$) and $\sigma$ is the molecular diameter. The formula is transformed for gaseous mixtures, and is compared with that of Thiesen, which agrees well with experiment. The agreement between the two formulæ is not satisfactory, except for mixtures of $O_2$ and $N_2$ and of He and $H_2$. The formula is also applied to binary mixtures accompanied by chemical change, and three cases have been studied: $H_2O - CH_3COOH$, where the observations show that a hydrate $CH_3COOH . H_2O$ exists in the solution; $H_2O - CH_3OH$, where the hydrate is $CH_3OH . 2H_2O$; and $H_2O - C_2H_5OH$, where the observations suggest that the hydrate in the solution is $C_2H_5OH . 3H_2O$ up to 40 mol. per cent. of $C_2H_5OH$, and $C_2H_5OH . 2H_2O$ for higher concentrations. H. N. A.

**2056. Viscosity of Gases. S. S. Kistler.** *Frank. Inst., J.* 207. *pp.* 389–395, *March,* 1929.

Examination of the customary derivations of the equation for the viscosity of gases reveals an error in the chain of reasoning. Viscosity is generally conceived to be due to the transfer of momentum through the gas, and it is in the method of arriving at the value for the quantity of momentum transferred that the error occurs. Perpetuation of the error is apparently due to the fact that the equation obtained is doubtless correct. The author's reasoning does not admit of concise abstraction. T. H. P.

**2057. Physico-Chemical Investigation of Dioxan. W. Herz and E. Lorentz.** *Zeits. f. phys. Chem.* 140. *Abt. A. pp.* 406–422, *Feb.,* 1929.

Dioxan is the trade name for diethylene-dioxide,



which usually contains large amounts of ethylene-acetal from which it is separated by careful distillation. In this paper are given the temperature-density relationships, densities of mixtures with water and the alcohols, viscosities, surface-tensions, specific heats, heats of evaporation, ebullioscopic and cryoscopic constants, vapour pressures, critical pressure, molecular weight in benzene, heat of combustion, refractive indices alone and in mixtures, and solubilities. The whole forms part of a study of the general behaviour of organic solvents. H. H. Ho.

**2058. Liquid Drops on the Same Liquid Surface. J. B. Seth, C. Anand and L. D. Mahajan.** *Phil. Mag.* 7. *pp.* 247–253, *Feb.,* 1929.

Liquid drops are formed from a liquid and float on the surface when a fine spray of water falls on the surface of water, or when a glass vessel containing methylated spirit is bowed across its edge. Floating liquid drops are formed in a variety of other ways, such as when condensed drops of aniline fall from the delivery tube on the surface of the aniline. The conditions for the formation of these liquid drops were investigated by means of the Boys soap solution and a solution of phenyle in water. The maximum and minimum heights from which the liquid had to fall in order to form primary and secondary drops was observed. Liquids were classified according to the formation or non-formation of the floating drops. F. J. B.

**2059. Surface Tension. A. W. Porter.** *Phil. Mag.* 7. *pp.* 624–630, *March,* 1929.

Discusses certain points in connection with the rise of liquids in capillary tubes, the weight of drops from tubes of various diameters, and the vanishing of surface tension near the critical point. Criticises Laplace's theory, which maintains that vanishing of the surface tension takes place only when the densities of the two phases are the same. This is found not to be so when an attempt is made to get a better approximation by recognising that the centres of molecules cannot approach nearer than their diameter. E. E. F. d'A.

**2060. Plastic Cellulose in Scientific Research. K. Hickman and D. E. Hyndman.** *Kodak Research Lab., Comm. No.* 370. *Frank. Inst., J.* 207. *pp.* 231–244, *Feb.*, 1929.

This article shows how transparent cellulose compounds may be built into useful laboratory apparatus. First the properties of pyroxylin (celluloid) and acetate base (cellulose acetate) are discussed, and then constructions with pyroxylin are described under the operations of cutting, shaping, welding [(*a*) to like material, (*b*) to glass and other substances] and laminating, the directions given serving also for acetate base. Strength and rigidity, tinting and sphere of usefulness next receive attention. An important application would appear to be the construction of models of buildings in which the lay-out of the interior down to such details as upper floors, stairs, fireplaces, radiators, bathroom fittings and furniture could be exhibited. H. H. Ho.

**2061. Rigidity of Wool and its Change with Adsorption of Water Vapour. J. B. Speakman.** *Faraday Soc., Trans.* 25. *pp.* 92–103, *March*, 1929.

The rigidity of dry Cotswold wool fibres was studied as a function of fibre diameter, and the influence of adsorbed water on the rigidity of the wool fibres was determined under adsorption and desorption conditions. Expressions are given relating the rigidity to the amount of water adsorbed and to the relative humidity. An analysis of the results indicates that the reduction in rigidity is caused by water adsorption on particular groups in the wool molecule, but the simplicity of the rule is masked by the fact that water can be adsorbed in two other ways in addition. AUTHOR.

**2062. Method of Ritz for the Solution of Problems in Elasticity. G. R. Goldsbrough.** *Phil. Mag.* 7. *pp.* 332–337, *Feb.*, 1929.

Shows that Ritz's result can be more speedily obtained by a method devised by the author for the solution of some tidal problems [see Abstract 1194 (1928)]. The method has the additional advantage of showing how the series satisfies the differential equation although the individual terms do not. W. G. B.

**2063. Nature and Form of the Contact between Two Elastic Bodies Pressed Together by a Given Force. H. H. Jeffcott.** *Phil. Mag.* 7. *pp.* 453–459, *March*, 1929.

Hertz's theory is carried to a further stage, and the use of tables of elliptic functions in determining the stresses and the form of the contact is rendered unnecessary by the use of curves, which enable approximate results to be obtained readily. J. S. G. T.

**2064. Dynamical Method for Young's Modulus. K. Prosad.** *Phil. Mag.* 7. *pp.* 548–554, *March*, 1929.

The measurement is made by determining the frequency of vibration of a bar of the material to which an attachment of soft iron is added to electrically maintain the vibrations when the bar is non-magnetic. W. H. GE.

**2065. Rubber Structure Research and its Bearing on the Elastic Properties of Colloids in General. E. A. Hauser.** *Indust. and Engin. Chem.* 21. *pp.* 249–251, *March,* 1929.

The author points out that research on rubber structure within the last few years can be classified into the following three groups: (1) the isolation of two constituents of rubber; (2) the transformation of one constituent into the other; (3) X-ray interpretation of rubber structure. Concerning the nitrogen content in purified rubber, this is said to vary considerably with the age and the source of the latex. The transformation of alpha into beta modifications of rubber, and *vice versa,* can be induced by heating, milling, stretching, freezing and solvents. The constitution of rubber is fully discussed, and reference is made to the terminology of Wolfgang Ostwald wherein rubber would be considered to be "iso-colloid," *i.e.,* the beta modification of solid structure is swollen in the liquid alpha modification. On X-ray interpretation of rubber structure reference is made to the work of Katz and the present author in collaboration with Mark. J. K.

**2066. Anti-Shock Suspensions. R. Müller.** *Ann. d. Physik,* 1. 5. *pp.* 613–657, *March* 12, 1929.

Critical examination and experimental work show that among the published anti-shock suspensions that of Julius (*Wied. Ann.* 56. p. 151, 1895; *Ztschr. f. Instr.* 16. p. 267, 1896, and 18. p. 85, 1898; *Ann. d. Physik* 18. p. 206, 1905) is on the whole the best, but is susceptible to improvements. Its action is based on forced vibrations; certain phenomena are explained. A new method of damping by the internal friction of liquids is given. A table apparatus is devised, in which the vertical components of shocks are reduced, the horizontal oscillations are slowed down, and liquid damping is applied. A. D.

**2067. Motion of a Particle on a Rough Sphere, including the Case of a Rotating Sphere. A. F. Stevenson.** *Phil. Mag.* 7. *pp.* 569–580, *March,* 1929.

A mathematical paper dealing with the motion of a particle on a rough sphere (i) when the "friction" is assumed to vary as the velocity, and (ii) when it is of normal type. The results of variations in the magnitude of the coefficient of friction are indicated, and the case where the sphere rotates is also dealt with. C. A. S.

**2068. Motion of a Body of Variable Mass. T. Levi-Civita.** *Accad. Lincei, Atti,* 8. *pp.* 621–622, *Dec.* 16, 1928.

Pursuing the argument of the previous paper [Abstract 1757 (1929)] the author shows that force equals rate of change of momentum even when the change of mass is due to incident radiation. E. E. F. d'A.

**2069. Tables of Lagrangean Coefficients for Interpolating without Differences. E. V. Huntington.** *Am. Acad., Proc.* 63. *pp.* 421–437, *March,* 1929.

**2070. Action of a Viscous Fluid on an Obstacle. Case of the Ellipsoid. J. Pérès.** *Comptes Rendus,* 188. *pp.* 440–441, *Feb.* 4, 1929.

The method of a preceding note [Abstract 1764 (1929)] is applied to the case of an ellipsoid, the action of the fluid on it being expressed in a similar way to that of a sphere in the former paper. The equations denoting the resultant and the moment of action of the fluid are quite simple, but containing as they do a sign of integration they have not received the attention which has been given to the formulæ of Faxén for the sphere. T. B.

**2071. New Theory of Fluid Resistance. P. Noaillon.** *Comptes Rendus*, 188. *pp.* 441–443, *Feb.* 4, 1929.

**2072. Hydrodynamics and the Kinetic Theory of Gases. Y. Rocard.** *Comptes Rendus*, 188. *pp.* 553–554, *Feb.* 18, 1929.

The author has for several years been examining, in the light of the kinetic theory, the limits of the validity of classical hydrodynamics. Most of the experimental facts are still a mystery to the hydrodynamicians, the explanation being sought by some in the insufficiency of Stokes' equations, and by others in the imperfections of the integration of the classical equations. Much light is thrown on the question with the aid of the kinetic theory of gases. If, for the general outline obtained by applying the principle of inertia of a fluid, one substitutes a particular model in place of the " fluid," some new precisions are naturally obtained. It is necessary to recognise that near the walls the gas or liquid is no longer a fluid, and the equations of hydrodynamics are not satisfied. It is only at a distance of, say, three or four mean free paths from the walls that the usual conditions of a fluid are fulfilled. T. B.

**2073. Problem of Hydrodynamics. H. Villat.** *Comptes Rendus*, 188. *pp.* 597–599, *Feb.* 25, 1929.

The author considers a hydrodynamical problem previously studied by Riabouchinsky (*ibid.* 174. p. 1226, 1922) which is stated as follows: in a plane XOY a liquid flows parallel to OX and meets two parallel planes situated one behind the other and symmetrical with respect to OY. The permanent state will then contain two vortices symmetrically situated. A simple artifice is now given for coping with the problem and consists in dealing mathematically with events in one of the four angles formed by the axes XOY. H. H. Ho.

**2074. Vertical Force on a Cylinder Submerged in a Uniform Stream. T. H. Havelock.** *Roy. Soc., Proc.* 122. *pp.* 387–393, *Feb.* 4, 1929.

As a step towards the calculation of all the forces acting upon a floating body in motion, the forces on a submerged cylinder are calculated from the successive image systems which represent the flow. The well-known " wave-resistance " formula is reproduced, and the vertical force obtained. It alters in direction at a speed which is very close to that at which the surface elevation over the cylinder changes sign. It is also verified that, to the degree of approximation considered, the moment of the fluid pressures vanishes. W. G. B.

**2075. Forces on a Solid Body Moving through a Viscous Fluid. S. Goldstein.** *Roy. Soc., Proc.* 123. *pp.* 216–225, *March* 6, 1929.

Proves that if a solid moves through a viscous fluid of density $\rho$ with velocity U, the drag is $\rho U \times$ the inflow along the wake; and the force in any direction perpendicular to the direction of motion is $\rho U \times$ the

integral circulation round a cylinder with generators perpendicular to both directions, at a great distance, and cutting the "wake" at right angles.
W. G. B.

**2076. Steady Flow of a Viscous Fluid past a Fixed Spherical Obstacle, at Small Reynolds Numbers. S. Goldstein.** *Roy. Soc., Proc.* 123. *pp.* 225–235, *March* 6, 1929.

Oseen's equations for the flow of a viscous fluid past a sphere are integrated completely, and a table of the values of the drag coefficient is given. Comparison with the values calculated from an empirical formula given by Zahm, deduced from collected experimental results, shows very fair agreement. W. G. B.

**2077. Air-Flow round a Circular Cylinder. A. Fage.** *Phil. Mag.* 7. *pp.* 253–273, *Feb.*, 1929.

Describes the results of an examination of the air-flow round a circular cylinder in the region where the boundary layer separates from the surface. The cylinder was 8·9 in. dia. and was suspended in a 4-ft. wind tunnel. Air velocities between 22 and 71·4 ft./sec. were used. It is shown that there is a critical point on the cylinder where a transition from the laminar to the turbulent state of flow in the boundary layer begins. The critical value of Reynolds' number for the boundary layer progressively increases with wind speed over the range investigated. The separation of the boundary layer from the surface occurs just beyond the critical point.
J. W. T. W.

**2078. X-Ray Examination of Salts of Fatty Acids. S. H. Piper.** *Chem. Soc., J. pp.* 234–239, *Feb.*, 1929.

X-ray photographs taken with the K$\alpha$ rays of copper or iron reflected from the layers of the salts pressed on a glass strip and mounted on a Müller spectrograph show that the potassium salts of the fatty acids have spacings which increase uniformly with the carbon content from 2 to 24 atoms. For acid salts, that is, equimolecular compounds of free acid and neutral salt, another similar series of spacings exists. In salts of this type the chain cannot be accounted for by a tetrahedral angle of 109° 28′ between the lines joining the centres of successive atoms, at least 111° 46′ being required. T. H. P.

**2079. Interpretation of X-Ray Crystal Photographs. Part I. Use of Photographic Grids. W. H. George.** *Phil. Mag.* 7. *pp.* 373–384, *Feb.*, 1929.

The paper describes a photographic grid method, applicable to any X-ray spectrometer, of measuring X-ray photographs. The photographic plate or film is supported in the X-ray camera entirely by geometric constraints. A flash of light together with a printing frame also fitted with geometric constraints is used to impress upon the X-ray photograph an image of some network suitable for the interpretation of the particular X-ray photograph. A single calibration photograph is taken and is used to fix accurately the geometric constraints of the printing frame. Any subsequent photograph then shows on development both the X-ray photograph and a correctly aligned interpretative grid. An example is given. Various modified applications of the method in X-ray crystallography are discussed, and also the application of grid methods to research in other subjects. W. V. M.

**2080. Evaluation of Powder X-Ray Photographs. G. Kettmann.** *Zeits. f. Physik*, 53. 3–4. *pp.* 198–209, 1929.

Describes a graphical method of evaluating powder-photographs when the cell size is not known. It depends upon extrapolation of a curve and its special features are independence of a knowledge of the fundamental lattice constants and of systematic errors. **Errata,** *ibid.* 54. 7–8. p. 596, 1929. W. H. Ge.

**2081. Precision Measurements of X-Ray Reflections from Crystal Powders. Lattice Constants of Zinc Carbonate, Manganese Carbonate and Cadmium Oxide. J. Brentano and J. Adamson.** *Phil. Mag.* 7. *pp.* 507–517, *March*, 1929.

To determine the rhombohedral angle $\alpha$ of the carbonates a high degree of accuracy is needed in measuring the lattice spacings. The authors have carried out new measurements, using a method based on the general focussing condition for the reflection from a powder to which J. Brentano has recently called attention, and a previously described instrument. The value of $\alpha$ for zinc carbonate was found to be 103° 27′, which agrees with the value 103° 28′ based on a goniometric determination by Rose, $d_{100} = 5\cdot493 \pm 0\cdot005$ Å., side of elementary cleavage rhomb $a = 5\cdot928 \pm 0\cdot005$ Å., volume of elementary cleavage rhomb $v = 1\cdot877 \pm 0\cdot015 \,.\, 10^{-22}$ cm.$^3$ For manganese carbonate $\alpha = 102° 50'$, Buckley's goniometric value 102° 50·3′, de Schulten's value 102° 50′ ; $d_{100} = 5\cdot666 \pm 0\cdot005$ Å., $a = 6\cdot064 \pm 0\cdot005$ Å., $v = 2\cdot039 \pm 0\cdot015 \,.\, 10^{-22}$ cm.$^3$ These values of $\alpha$ are compared with those previously obtained for manganese carbonate and calcite. Cadmium oxide can be used, with the K radiation of copper, molybdenum, rhodium and silver, as a standardising substance to avoid too great penetration of the X-rays into the crystal powder investigated. H. N. A.

**2082. X-Ray Study of System Palladium-Hydrogen. J. D. Hanawalt.** *Phys. Rev.* 33. *pp.* 444–453, *March*, 1929.

A unique grating parameter $a_0 = 4\cdot017$ Å. results when palladium is charged with hydrogen either electrolytically or from the gas phase, in disagreement with the results of Linde and Borelius. Larger values of $a_0$ are possible, but are not stable at 20° C. A difference in stability between some of the electrolytically charged specimens as compared to those charged from the gas phase is associated with the mechanical state of the micro-crystals in the two cases. The concentration $Pd_2H$ is associated with the value $a_0 = 4\cdot017$. The $L_{111}$ absorption limit of palladium is changed by the presence of hydrogen which causes a shift of the main edge of 0·87 X.U. towards shorter wave-lengths and the occurrence of a secondary absorption 10 X.U. towards shorter wave-lengths. This is taken to indicate a chemical combination between palladium and hydrogen atoms. The molecule PdH is suggested. Impurities in the palladium affect very markedly its occlusion of hydrogen. The unique value $a_0 = 4\cdot017$ does not appear, but rather all distensions in the range 3·885 to 4·030 are observed. It is suggested that impurities in the palladium might account for the difference between the results of Yamade and those of McKeehan. Author.

**2083. Structure of Trimethyl Ethyl Ammonium Chlorostannate. R. W. G. Wyckoff and R. B. Corey.** *Am. J. Sci.* 17. *pp.* 239–244, *March*, 1929.

From Laue and spectral photographs it is deduced that the unit cell is cubic, containing four molecules of $[N(CH_3)_3\,C_2H_5]_2\,SnCl_6$ and having an edge of 13·17 Å. Space group is Ti — 6. The proposed structure is $CaF_2$-like with the chlorostannate groups of the same size, shape and distribution as in $(NH_4)_2SnCl_6$. The suggested arrangement of the carbon and nitrogen atoms of the $N(CH_3)_3C_2H_5$ groups gives approximately the same distances found in analogous compounds. W. H. Ge.

**2084. Behaviour of a Single Crystal of Zinc subjected to Alternating Torsional Stresses. H. J. Gough and H. L. Cox.** *Roy. Soc., Proc.* 123. *pp.* 143–167, *March* 6, 1929.

The crystal was made by the Bridgeman method and was tested in the apparatus previously described [see Abstract 1814 (1928)]. The slip phase is the basal plane (0001). Three possible slip directions exist, namely, the three primitive directions contained by the basal plane. The direction selected, in any particular case, is determined purely by resolved shear stress considerations. The twinning plane of zinc is the first order pyramidal (two)—$10\bar{1}2$ type—producing a twinned basal plane making an angle of about 94° with the original basal plane. A. A. D.

**2085. X-Ray Structure and Magnetic Properties of Single Crystals of Heusler Alloy. H. H. Potter.** *Phys. Soc., Proc.* 41. *pp.* 135–142, *Feb.*, 1929.

The X-ray structure of single crystals of Heusler alloy has been examined by the single crystal rotation method. The alloy is found to crystallise as a body-centred cube with lattice constant 2·95 Å.U. The aluminium atoms are distributed so as to lie on a face-centred cube with lattice constant = 5·9 Å.U. Directional magnetic properties have been studied by a method previously described [see Abstract 1399 (1928)] and have been found to be identical with those of nickel which has a face-centred cubic structure. It is suggested that this may be interpreted as indicating that the manganese atoms—whose positions cannot be determined by X-ray analysis—also lie in a face-centred cubic lattice. Author.

**2086. X-Ray Investigation of the Structure of Hardened Carbon Steel. G. Kurdjumow and E. Kaminsky.** *Zeits. f. Physik*, 53. 9–10. *pp.* 696–707, 1929.

The writers show that the space centred tetragonal lattice structure found for hardened steel persists throughout the interior of the test specimen, and is not confined to a thin surface layer as found by Honda. The variation with carbon content of the axes ratio and the parameter of the tetragonal lattice was determined for steels containing from 0·64 to 1·44 % carbon. The axes ratio increased linearly with the steel content, from 1·025 to 1·058. The one parameter *c* increases with the carbon content, the other *a* decreasing somewhat. The change in structure after holding the specimen at 100° C. was investigated. The tetragonal structure tends to pass over to the cubic, the axes ratio decreasing gradually. W. S. S.

**2087. Extension of Cadmium Crystals. W. Boas and E. Schmid.** *Zeits. f. Physik*, 54. 1–2. *pp.* 16–45, 1929.

The mechanism of plastic deformation of metallic crystals follows the usual laws laid down for other materials in the case of cadmium, the X-ray analysis of the translation elements of cadmium showing a close analogy to zinc. The investigation of the extension curves and the rate of flow show that the rate of crystallisation has a profound effect on the malleability of the crystal. The slower the crystallisation and the slower the cooling, the lower the value of the coefficient of plasticity. Tempering has also a great effect. A diagrammatic illustration of the lattice movement during deformation is given and discussed. The various phenomena connected with deformation are dealt with in detail. The paper is complete with both experimental and theoretical data. S. G. B.

**2088. Crystalline Structure of Thin Metallic Layers. S. Dembinska.** *Zeits. f. Physik*, 54. 1–2. *pp.* 46–52, 1929.

By means of a Bragg apparatus the crystal structure of thin metallic films is studied. The orientation of the crystalites is noted in the case of films prepared either by kathode or thermal sputtering. Metal layers of thickness 7 to 18 mμ are examined in the course of the work. The basis on which the layer is deposited has a great effect on the crystal structure of the thin metallic layer. The layers show regular arrangement and structure. The comparison of kathode-sputtered layers with those of thermal production show that the latter are of much clearer and regular arrangement. Full experimental details are given. S. G. B.

**2089. Distribution of Charge in the Chlorine Ion in Rock-Salt. G. W. Brindley and R. G. Wood.** *Phil. Mag.* 7. *pp.* 616–623, *March*, 1929.

Reasons are given for supposing that the departure from spherical symmetry of an ion in a lattice of the rock-salt type is probably small, so that the modification due to neighbouring ions is mainly a change in the radial distribution. The difference between the theoretical and experimental F curves is thus accounted for. E. E. F. d'A.

**2090. Diamonds. L. Sesta.** *Phil. Mag.* 7. *pp.* 488–493, *March*, 1929.

By means of the intermittent or musical arc higher temperatures are obtained than by means of the continuous arc or the electric furnace. The spectrum of the intermittent arc is equal to that of an intense spark. With this the liquid form of carbon was obtained, and minute crystals were formed if the cooling were extremely rapid so that graphite could not be formed. A. D.

**2091. Metastability of Elements and Compounds as a Consequence of Enantiotropy or Monotropy. E. Cohen and H. L. Bredée.** *Zeits. f. phys. Chem.* 140. *Abt. A. pp.* 391–405, *Feb.* 1, 1929.

An investigation has been made with chemically and physically pure preparations of rhombic ($\alpha-$) and rhombohedral ($\beta-$) potassium nitrate, of the densities, transformation heats and temperatures, expansion coefficients, and volume changes, which obtain about the transformation temperature of $\alpha - KWO_3 \rightleftharpoons \beta - KWO_3$. The latter has been evaluated as 127° ± 1° C. The determinations were carried out by means of C. T. Smith's differential gas dilatometer [see Abstracts 1052 and 1439 (1929)]. Earlier data were found to be very inaccurate. A new monotropic form ($\gamma$) of potassium nitrate has also been discovered of density greater than that of the $\alpha -$ or $\beta -$ forms. H. H. Ho.

**2092. Ionisation Potentials of the Rare Earth Elements in Relation to their Position in the Periodic System. L. Rolla and G. Piccardi.** *Phil. Mag.* 7. *pp.* 286–301, *Feb.*, 1929.

The spectroscopic data in the case of these elements are not sufficient to enable the ionising potentials to be calculated; other methods of comparing the binding forces with which the valency electrons are retained in their atoms are mentioned, including that based on astrophysical observations, and the spectrum of the solar corona during total eclipses. The authors employ a method in which a flame passes through a fine metallic gauze, and strikes a metal plate connected to the gauze electrically; atoms capable of being ionised into ions and electrons are introduced into the flame, and the ions go to one electrode the electrons to the other, causing a current which can be measured with a galvanometer. The electrodes were of platinum for experiments with the lighter elements, but with the rare earth elements a coal-gas oxygen flame was needed, and the gauze was of iridium. The bead of salt used was weighed before and after the experiment, so that the number of atoms per second could be measured. In this way it is possible to find the value of K in the equation expressing the law of mobile equilibrium, $U = -RT^2 \, d \log K/dT$, where U is the ionising energy, so that if T is known U can be calculated and V the ionising potential found. This has been done for nine of the rare earth elements. The ionisation potentials of all the elements, including the above, have been plotted against the atomic numbers, and a graph obtained showing the periodicity of the Mendelejeff system; this presents striking characteristics in agreement with the atomic theories of Bohr and Hund which characteristics are discussed in detail.

H. N. A.

**2093. Orientation of Organic Compounds on Cylindrical Glass Surfaces and in the Surface Layer of Glass. J. J. Trillat.** *Comptes Rendus*, 188. *pp*. 555–556, *Feb*. 18, 1929.

Uses the method previously employed with mercury as a support for a film of fatty acid, but using an optically polished glass cylinder to support the film. The glass is coated with a film of palmitic acid less than 0·01 mm. thick. This is placed in the spectrograph previously described, so that the slit is parallel to the axis of the cylinder and the X-ray beam is tangential to the glass surface. A number of lines were photographed parallel to the axis of the cylinder, which corresponded to reflections on surfaces 35·6 Å. apart. Such surfaces have two opposed molecules of the fatty acid between them, and bound thin cylindrical sheets superposed on one another and surrounding the glass cylinder. It appears then that the long molecules are arranged radially to the surface. In addition to the above lines there are imperfect Debye-Scherrer rings. These correspond to distances of 3·7 and 4·1Å., and show that the molecules or microcrystals can turn about their radial axis of orientation. The surface of the glass has also been studied. An intense band has been found parallel to the axis of the cylinder, which seems to indicate that the molecules in the surface are orientated, probably perpendicularly to the surface.

H. N. A.

**2094. Parachor and Chemical Constitution. Part X. Singlet Linkages in Chelated Coordinated Compounds. S. Sugden.** *Chem. Soc., J. pp*. 316–330, *March*, 1929.

The parachor anomaly detected in the higher halides is found to be reproduced in the coordinated compounds of the uni-, bi- and tri-valent metals, thallium, beryllium, and aluminium. The parachors of all these compounds are accounted for by the hypothesis of singlet linkages. In accordance with this view, structures containing singlet linkages in the molecule are suggested for basic beryllium propionate and aluminium bromide. An alternative hypothesis which accounts for most of the parachor anomalies is examined. In this the duplet linkages are retained and the sharing of an electron brings about a contraction of about 12 units in the parachor. This hypothesis is, however, shown to be incompatible with the available data for mercury and thallium compounds. The free $\beta$ diketones and certain derivatives are found to possess an open-chain structure and are not coordinated. The following atomic parachors are determined: Hg = 69, Tl = 64, Pb = 76, Be = 38, Al = 39. [See Abstract 2416 (1927).] J. N. P.

**2095. Detection of Isotopes of Lead by the Band Spectrum Method. S. Bloomenthal.** *Science*, 69. *p*. 229, *Feb*. 22, 1929.

Uranium lead of atomic weight 206·1 and ordinary lead of atomic weight 207·2 were compared by means of a 21-ft. Rowland grating. Each line in the band spectrum of uranium lead corresponds to the long wave-length member of one of the groups of three lines in the ordinary lead spectrum. The numerical results are in good agreement with theory if PbO is taken as the emitting molecule. H. N. A.

**2096. Separation of Isotopes. J. N. Brönsted and G. Hevesy.** *Phil. Mag.* 7. *pp*. 631–632, *March*, 1929.

In a recent paper Harkins and Mortimer [see Abstract 416 (1929)] have criticised the work of the authors on the separation of the isotopes of mercury, saying that no evidence was given that the mercury employed was pure. Gives reasons which support its purity. H. N. A.

**2097. Relation between the Atomic Weights of Uranium, Radium, RaG and Helium. S. Meyer.** *Akad. Wiss. Wien, Ber.* 137. 2*a*. *Nos*. 9–10. *pp*. 599–606, 1928.

Makes use of Aston's latest determination of the atomic weight of helium, which, for the neutral atom, gives $4 \cdot 0021_6$, and Hönigschmid and Schilz's value for uranium, 238·14. Calculates the atomic weights of radium and of radium lead, RaG, taking into account the loss of mass due to the ejection of $\alpha$ and $\beta$ particles, and that due to emission of energy. When the facts that "uranium" is really a complex of UI with from 3 to 4 % of AcU, and that radium lead is a complex of RaG + AcD in about the same proportion are considered, the calculated and observed values for RaG are almost identical, but the value calculated for radium is almost 0·1 higher than the experimental value of Hönigschmid. The difficulties in the way of obtaining a correct value for the atomic weight of radium are pointed out, and a new determination is considered very necessary. H. N. A.

**2098. Atomic Weights. G. P. Baxter.** *Am. Chem. Soc., J.* 51. *pp*. 647–654, *March*, 1929.

Reviews work published in 1928 on potassium, titanium, copper, caesium, barium, silver, cerium, erbium, rhenium, actinium-lead and uranium; the existence of $Ne^{21}$ has been confirmed, and the proportion of the three isotopes in neon has been estimated as $Ne^{20} : Ne^{21} : Ne^{22} = 88 : 2 : 10$; additional isotopes of Zn and Ge have been discovered. The list of atomic weights of the American Chem. Soc. for 1929 is given; changes are made from the 1928 list for the following elements, the new atomic weights are recorded here: H, 1·0078; P, 31·02; S, 32·06; Ba, 137·36; Ce, 140·13; Er, 167·64; K, 39·10; Ra, 225·97; Th, 232·12; U, 238·14. The value for hydrogen depends largely on the evidence of the mass spectrograph. H. N. A.

**2099. Synthesis of Elements. G. I. Pokrowski.** *Zeits. f. Physik*, 54. 1–2. *pp.* 123–132, 1929.

Obtains an expression for the energy liberated when four protons and two electrons unite to form a helium nucleus, and calculates the consequent loss of mass. If the energy is liberated as a quantum, the corresponding wave-length is nearly the same as that found for one of the components of the Hess high-altitude radiation by Millikan and Cameron, $\lambda_4 = 45\cdot3 \times 10^{-13}$. Estimates the amount of matter converted into radiation in the interior of the stars every second per gm. and finds from the ratio of 0·1 to 1, which exists between the intensity of the Hess radiation and the total radiation received at night from the stars, that energy is being converted into matter in " empty " space about 120 times as fast as matter is being converted into radiation in the stars. Considers the formation of other elements by the union of protons and electrons, and comes to the conclusion that the frequencies of the rays given out in the formation of the different elements are equal to whole numbers of " chronones " or " atoms of time." This leads to the identification of Millikan and Cameron's radiation $\lambda_1 = 2\cdot69 \times 10^{-13}$ cm. with the formation of iron from protons, $\lambda_2 = 5\cdot47 \times 10^{-13}$ cm. with that of silicon, $\lambda_3 = 10\cdot5 \times 10^{-13}$ cm. with that of oxygen. H. N. A.

**2100. Measurement of the Concentration of Monatomic Hydrogen, Nitrogen and Oxygen. E. Wrede.** *Zeits. f. Physik*, 54. 1–2. *pp.* 53–73, 1929.

Two vessels are joined by a very small opening; in one of them molecules are dissociated into atoms electrically, in the other vessel atoms which diffuse through the narrow slit-shaped opening quickly recombine to form molecules. There will be a difference of pressure between the two vessels, and a formula is given by means of which the concentration of the atoms in the first vessel can be calculated from the ratio between the pressures. In the case of atomic hydrogen it was possible to obtain a curve showing the exact relation between the atomic concentration and the current employed to produce the dissociation. In many practical cases it has been found that a pure diffusion effect is sufficient to produce transference of the atoms. In the case of nitrogen, activated in the usual way, a small percentage of free atoms can be shown to exist. The atomic concentration can be raised to from 30 to 40 % by using a succession of condenser discharges, " Stossfunkenentladungen." It was found that a limit was reached, since the discharge had also a recombination effect. The same method gives good results with oxygen. Small dust particles which glow owing to their catalytic action serve as indicators of the length of the atom's life. H. N. A.

**2101. Atomic Volume Relations in Certain Isomorphous Series. A. F. Hallimond.** *Min. Mag.* 22. *pp.* 70–76, *March*, 1929.

A theoretical paper in which the pressure-volume relation $pv = k$ shown by Richards to apply to the free alkali metals is examined [See T. W. Richards, *J. Chim. Phys.* 25. pp. 83–119, 1928]. $k$ is shown to be approximately constant for potassium and sodium, though agreement is better if the internal pressure is taken as somewhat higher than is given by the relation $p = 1/\beta$. Compressibility ($\beta$) is shown to be approximately proportional to the atomic volume (V) in each eutropic series, but the ratio K ($= V/\beta$) varies widely between different series. The rate of change of compressibility ($d\beta/dp = 1/p^2$) deduced for potassium and sodium is too low for low pressures, but steadily approaches the observed values as pressure increases. Finally, it is shown that satisfactory values for the compressibilities of the halogens are deducible from those of their alkali salts and the alkali metals by adopting a different value for K (4·0 as against 1·7 for the free metals). C. A. S.

**2102. Intensity Measurements of Molecular Radiations from Gases. F. Knauer and O. Stern.** *Zeits. f. Physik*, 53. 11–12. *pp.* 766–778, 1929.

The authors describe fully an improved form of the apparatus previously developed for the measurement of the intensity of molecular radiations from light gases [see Abstracts 558 and 559 (1927)]. The radiation streams out through a slit into an evacuated vessel and impinges on the slit opening of another evacuated vessel, producing a pressure in it, the value of which is measured by means of a hot wire manometer. The construction of the manometer and the measurement of its sensitivity, the estimation of the time of duration of the end pressure, the bridge circuit and compensation, and the calibration of the manometer are also fully described. The error of the measurements of the relative intensities of the radiations is only 1 in 1000, and for absolute values of the intensities the errors should be less than 1 %. The direct estimation of the mean free path of the hydrogen molecules is described, as an example of the use of the method. R. C. F.

**2103. Reflection of Molecular Radiation. F. Knauer and O. Stern.** *Zeits. f. Physik*, 53. 11–12. *pp.* 779–791, 1929.

Shows, from results obtained for optical gratings, that molecular radiations from hydrogen and helium are partially specularly reflected from highly polished surfaces when grazing incidence is used. The amount specularly reflected is found to be in agreement with the de Broglie wave theory, being higher the nearer the rays are to grazing incidence. The angle at which specular reflection can be observed agrees with the value calculated from the wave-length and the estimated surface unevenness, whilst decreasing the temperature of the radiation increases the percentage specularly reflected. No definite results could be obtained using ruled gratings. Specular reflection is also shown to appear when crystal gratings, such as the cleavage surface of rock-salt, are used. Apparently this phenomenon for crystal cleavage surfaces is to be considered as due to diffraction, but the exact reasons are still to be found. R. C. F.

**2104. Significance of the "Packing Fraction." M. Françon.** *J. Phys. Chem.* 33. *pp.* 296–300, *Feb.*, 1929.

The divergence of the mass number of an atom from a whole number divided by the mass number was called by Aston the "packing fraction." The bearing of the determination of the packing fraction on the present knowledge of the forces which hold the protons and electrons together in the nucleus was discussed. The confirmation of the atomic weight of caesium, as determined by Richards and Archibald, by T. W. Richards and M. Françon, and the simple nature of caesium require that the packing fraction should be about three times as great as given in Aston's curve. The packing fraction contributes, with the atomic number and the mass number, to the sum of knowledge of the nucleus: its charge, its mass, the number of electrons in the nucleus, and the possible arrangement of the protons and electrons in the nucleus. F. J. B.

**2105. Distribution of Electrons in Atoms. L. M. Alexander.** *Phil. Mag.* 7. *pp.* 517–522, *March*, 1929.

Works on the assumption that, just as the energy necessary to remove the most lightly bound electron increases to a maximum as the K and L groups approach completion, reaching a maximum in He and Ne respectively, and dropping to a low value for Li and Na, when a new group is commenced, so a similar action may be expected when a sub-level is completed. After this point a decrease in the ionisation potential is to be expected of considerably smaller magnitude than that found when a principal group is completed. Graphs are constructed showing the relation between $\sqrt{\nu/R}$ and the atomic number for certain groups of elements, and a table is constructed showing the number of electrons in the sub-levels, using Bohr's general scheme. H. N. A.

**2106. Triplets of Helium. J. A. Gaunt.** *Roy. Soc., Proc.* 122. *pp.* 513–532, *Feb.* 4, 1929.

Criticises Heisenberg's treatment of the theory of the helium atom, which is based on Schrödinger's equation. The equation of Dirac seems likely to give better results than that of Schrödinger in wave-mechanics; it makes it possible to connect the spin of the electron with the theory of relativity, and explains the doublets of the hyhrogen-like atom. Dirac's *q*-number theory has been translated into wave-mechanics by Darwin. The author deals with the theory of an atom with two extra-nuclear electrons on the basis of the Dirac equation, omitting calculations which are independent of the spin, which are the same on either theory. The fine structure of the triplets and intercombinations between ortho- and para-states, which are spin effects, are dealt with. The bearing of the new theory on the explanation of the spectra of the gaseous nebulæ is mentioned. The author includes part of the spin effect from the start in Dirac's equation, while Heisenberg at first completely neglects the spin perturbation and only introduces it later on. The author calculates the spin energies by means of integrals involving the wave-functions, and not from a mechanical model. A perturbation theory is developed for nearly degenerate systems, which is much the same as the ordinary perturbation theory. Numerical values are calculated for the separation of the extreme components of certain helium triplets; these are compared with those calculated by Heisenberg and those observed by Houston. H. N. A.

**2107. Triplets of Helium. J. A. Gaunt.** *Roy. Soc., Phil. Trans.* 228. *pp.* 151–196, *Feb.* 20, 1929.

Gives in detail the calculations the results of which were quoted in the author's recent paper on the subject [see preceding Abstract]. The structure of the helium triplets with one excited electron is worked out; the resulting spin separations are different from Heisenberg's, but in equally good agreement with experiment. The correct first approximation to the wave functions are found, and used to verify the ordinary classification and selection rules. Parallel work has been done for the deepest triplet of $O^{++}$, some of whose intercombination lines appear strongly in the spectra of the nebulæ. Estimates are made of the intensities of these lines, but the strength of the nebular lines is not explained by any new selection rule inherent in the new theory, and must be due to special conditions of the nebular gas. H. N. A.

**2108. Quantisation of the Asymmetric Top. H. A. Kramers and G. P. Ittmann.** *Zeits. f. Physik,* 53. 7–8. *pp.* 553–565, 1929.

It is shown how Schrödinger's equation in the case of the asymmetric top with arbitrary ratios of the moments of inertia can be solved by a separation of the variables leading to Lamé's differential equation. The eigen energies and eigen functions are obtainable immediately from the theory of Lamé's functions. Possible physical applications of the analysis to molecules containing more than two atoms are discussed briefly. W. S. S.

**2109. Perturbation Theory in Quantum Mechanics. A. H. Wilson.** *Roy. Soc., Proc.* 122. *pp.* 589–598, *Feb.* 4, 1929.

Discusses the convergence of a series of electronic perturbations. Though the series does not in general converge, yet it usually possesses the same asymptotic character as in the classical theory, and its use can, therefore, be justified. E. E. F. d'A.

**2110. Schrödinger's Wave Equation. Z. Horàk.** *Comptes Rendus,* 188. *pp.* 494–496, *Feb.* 11, 1929.

The author shows mathematically that following the fundamental ideas of wave mechanics according to Schrödinger one is led to associate at the movement of a nonholonome system the propagation of waves in the nonholonome space. R. S. R.

**2111. Dispersion and Refraction of Material Waves. H. Bauer.** *Phys. Zeits.* 30. *pp.* 139–142, *March* 1, 1929.

The relations between wave and group velocity of a wave packet corresponding to a particle, in their dependence on the field of force, and the fundamental frequency and rest mass of the particle, are worked out in detail. Refraction occurs when the material waves encounter a surface of potential discontinuity, the refractive index for passage from a region of zero potential energy to one of potential energy V being given by $n^2 = 1 - \frac{V}{\frac{1}{2}mv^2}\left(1 - \frac{V}{2h\nu}\right)$, or approximately for small values of the particle velocity $v$, by $n^2 = 1 - \frac{V}{E}$, where E equals the total energy (classically determined) of the particle. This result has been used in explaining Davisson and Germer's experiments on electron-scattering by nickel crystals. The analysis is applied to light quants simply by putting the rest mass equal to zero. W. S. S.

**2112. Relativity Theory of Divergent Waves. O. R. Baldwin.** *Roy. Soc., Proc.* 123. *pp.* 119–133, *March* 6, 1929.

Eddington's theory is generalised in order to discover all the non-spurious waves of the same general character at infinity as Eddington's waves. It is shown that there is only one fundamentally distinct wave of this type and it seems possible that all waves may be derived from this fundamental type. J. S. G. T.

**2113. Propagation of Light in the Ether. H. Malet.** *Comptes Rendus,* 188. *pp.* 443–445, *Feb.* 4, 1929.

The essential phenomena of the propagation of light—the result of the

Michelson and Fizeau experiments, the deviation of a light ray in a gravitational field—are deduced on the assumption that (1) the velocity of light, $c$, at a point in the ether is a function of the gravitational potential at the point, and (2) grad $c = o$. J. S. G. T.

**2114. A. N. Whitehead's Theory of Absolute Acceleration. W. Band.** *Phil. Mag.* 7. *pp.* 434–440, *March*, 1929.

The assumption that an accelerated observer uses at any moment a member of the consentient sets of coordinate systems is shown to lead to an inconsistency with fact. Had Whitehead employed a Newtonian space independent of an absolute time the moments for oppositely-moving observers would not have intersected and the inconsistency would not exist. The attempt to compromise between the idea of absolute acceleration and relative velocity possesses only doubtful logical justification. It is shown that the theory leads to the conclusion that during a total eclipse stars revealed near the sun's disc would exhibit a spectral shift to the blue, the shift increasing with the distance of the star; stars in the opposite ecliptic region would show a spectral shift to the red. The shift in the case of $\alpha$ Centauri relative to terrestrial sources would roughly equal 40 times the separation of the sodium lines. J. S. G. T.

**2115. Temporal Quantisation of Motion. G. Beck.** *Zeits. f. Physik*, 53. 9–10. *pp.* 675–682, 1929.

The value of the time-quantum, the chron, is deduced and the value $4{\cdot}37 \times 10^{-24}$ sec. found. Values of many other elementary quanta are deduced. Masses of protons and electrons are expressed in terms of $m$, $e$, $h$, R and $c$, the symbols having their customary significance. Similarly the gravitation constant, C, is expressed in terms of the same constants. Accelerated motion is briefly discussed, and a formula indicating an increase of mass with acceleration is deduced. J. S. G. T.

**2116. Einstein's New Formulation of the General Principle of Relativity. E. Wigner.** *Zeits. f. Physik*, 53. 7–8. *pp.* 592–596, 1929.

Einstein's theory of distant parallelism, developed in his unified theory of the gravitational and electromagnetic fields [see Abstract 1181 (1928)], is shown to lead to a general relativistic invariant formulation of Dirac's electron theory. J. S. G. T.

**2117. Place of Einstein's New Theory of Gravitation and Electricity. H. Reichenbach.** *Zeits. f. Physik*, 53. 9–10. *pp.* 683–689, 1929.

The space-type characterising Einstein's unified theory of the gravitational and electromagnetic fields [see Abstracts 69 and 70 (1929)] is conceived as a special case of the Weyl-Eddington space-type. It is not a special case of Riemannian space, but a collateral with this in the transition from metric space to euclidean space thus:

$$\begin{tikzcd}
 & \text{Metric space, } d(l^2) = o \arrow[dl, no head] \arrow[dr, no head] & \\
\begin{array}{c}\text{Einsteinian space}\\ R^{\ \tau}_{\mu\nu\sigma}(\Gamma) = o\end{array} \arrow[d, no head] & & \begin{array}{c}\text{Riemannian space}\\ \Gamma^{\tau}_{\mu\nu} = \Gamma^{\tau}_{\nu\mu}\end{array} \arrow[d, no head] \\
\begin{array}{c}\text{Euclidean space}\\ \Gamma^{\tau}_{\mu\nu} = \Gamma^{\tau}_{\nu\mu}\end{array} & & \begin{array}{c}\text{Euclidean space}\\ R^{\ \tau}_{\mu\nu\sigma}(\Gamma) = o\end{array}
\end{tikzcd}$$

The value of a unified field theory is briefly discussed. J. S. G. T.

**2118. Foundation of Einstein's New [Unified] Field Theory. R. Zaycoff.** *Zeits. f. Physik,* 53. 9–10. *pp.* 719–728, 1929.

The geometric basis of Einstein's unified field theory [see Abstracts 69 and 70 (1929)] and certain identities associated therewith are briefly referred to. The corresponding expression of the Hamiltonian principle is deduced for the general case to a first approximation, and for a particular case to a second approximation. J. S. G. T.

**2119. Relation of Einstein's Unified Field Theory to the Quantum Theory. I. Tamm.** *K. Akad. Amsterdam, Proc.* 32. 3. *pp.* 288–291, 1929. *In German.*

Quantum features characterising Einstein's unified field theory are developed by the aid of Dirac's electron theory. J. S. G. T.

## METEOROLOGY AND GEOPHYSICS.

**2120. Amount of Ozone in the Earth's Atmosphere and its Relation to other Geophysical Conditions. G. M. B. Dobson, D. N. Harrison and J. Lawrence.** *Roy. Soc., Proc.* 122. *pp.* 456–486, *Feb.* 4, 1929.

The observations tabulated are for the same stations and with the same apparatus as formerly [see Abstract 73 (1929)], and confirm earlier views regarding the annual variation and the relation with terrestrial magnetic conditions. Diagrams illustrate the typical distribution of $O_3$ over a cyclone and an anticyclone, giving generally higher values on the western part of the former and the eastern part of the latter. The evidence is against the existence of discontinuities in the $O_3$ distribution. Using the Bergen phraseology, there is a high $O_3$ content for polar air and low for equatorial air, indicating that these currents extend to large heights and bring their own stratosphere with them if the original $O_3$ contents are retained. For other conditions (1) maritime polar air has a mean $O_3$ value; (2) a warm sector a low $O_3$ value; (3) in the rear of a depression a large increase of $O_3$ occurs, indicating air of recent polar origin in the stratosphere; (4) occlusions often show a decrease of $O_3$; (5) a shallow polar current, little increase of $O_3$; (6) pressure surges show no connection with $O_3$ content; and (7) fohn conditions have no influence on $O_3$. The authors finally discuss the influence of sunlight on the formation and decomposition of $O_3$. R. S. R.

**2121. Intermittence of Springs. J. Versluys.** *K. Akad. Amsterdam, Proc.* 32. 2. *pp.* 88–93, 1929.

A mixture of gas or vapour and liquid in a subterranean channel can rise regularly under two conditions, called the foam and the mist conditions. Which of these will arise depends on the proportion in which the gas and liquid are mixed. This proportion is not only determined by the proportion in which they flow out, but also by their difference of speed and their absolute velocity. Due to the fact that the difference of speed is not the same under both conditions, a direct transition from one condition to the other is impossible. If in a part of the channel the intermediate conditions prevail, an intermittent flow will be the result.

AUTHOR.

**2122. Gravity Expedition of the U.S. Navy. F. A. V. Meinesz.** *K. Akad. Amsterdam, Proc.* 32. 2. *pp.* 94–99, 1929.

Gravity determinations were made in a submarine at 49 stations in the Gulf of Mexico, the Caribbean Sea, and on the way to and from Hampton Roads. Echo soundings were also made. Provisional computation of the results shows a positive anomaly of about 60 millidynes over almost the whole of the Gulf of Mexico except north of Yucatan and south of the Mississippi delta (+ 20 m.d.). There is no evidence of increased positive anomaly near the delta. In the Caribbean Sea south of Haiti and Porto Rico the mean anomaly is + 40 m.d. Anomalies above the Nares deep are very large, − 190 m.d. above the deep itself, + 25 m.d. north and − 10 m.d. south thereof. Negative anomalies continued to the west of the deep in a line therewith, − 120 m.d. north of Haiti and − 40 m.d. north of East Cuba. Above the Bartlett deep and the deep channel between St. Thomas and St. Croix similar though smaller anomalies were found. The results obtained in the Atlantic give no support to Wegener's drift theory. [See also Abstract 3184 (1928).]

C. A. S.

**2123. Ellipticity of the Terrestrial Equator. T. Banachiewicz.** *Comptes Rendus*, 188. *pp.* 492–493, *Feb.* 11, 1929.

The author contends that Bossolasco's deduction of the orientation of the gravitational equatorial ellipse [see Abstracts 1468 and 1469 (1929)] is invalid. Helmert's deduction is confirmed. J. S. G. T.

**2124. Deformation and Temperature. P. G. Nutting.** *Washington Acad. Sci., J.* 19. *pp.* 109–115, *March* 19, 1929.

A theoretical paper in which certain thermodynamical relations, in particular $dT/dv = P/Cp$ and $dH/dw = P/p$, and Richards' equation, $p + P = \pi + \kappa$ [where $p$ is the external pressure, P the internal (thermodynamical) pressure, $\pi$ the distending pressure due to molecular resistance, and $\kappa$ the kinetic pressure due to heat motion], are applied to observations made in 1907 on the elongation of a steel tape. Values for $\pi$ and $\kappa$ are calculated. The results are also applied to shear and friction in rocks, the heat evolution for certain average movements for average rocks being calculated. C. A. S.

**2125. Periods of Earthquake Frequency. C. Davison.** *Phil. Mag.* 7. *pp.* 580–586, *March*, 1929.

The paper is an expansion of one published by the author in *Nature*, 120. pp. 587–588, 1927, and deduces by means of harmonic analysis (as described in *Phil. Trans.*, 1893A. pp. 1108–1111) from the records of 2421 earthquakes in the northern hemisphere in the years 1701–1898, taken from Milne's Catalogue (*Brit. Ass. Rep.*, 1911, pp. 649–740) that the frequency of earthquakes in that hemisphere is periodic with periods of 11, 22, 33, 19 and 38 years, with maximum epochs in 1709, 1716, 1724, 1715–16, and 1724–25 respectively. The periods of 11, 33 and 19 years are the best marked, relating to all destructive earthquakes, those of 33 and 38 years only to those of intensities 2 and 3. The records for the southern hemisphere (303 earthquakes) are insufficient to give results.

C. A. S.

## ASTROPHYSICS.

**2126. Current Progress in Astronomy. W. E. Harper.** *Roy. Astron. Soc. Canada, J.* 23. *pp.* 119–130, *March*, 1929.

A review under the headings: (1) Solar System; (2) Stellar Universe; (3) Related Advances in Physics; (4) New Equipment.

**2127. Variation of the Sun's Diameter. G. Armellini.** *Accad. Lincei, Atti,* 7. *pp.* 959–961, *June* 17, 1928.

Gives an analysis of the observations of the sun's diameter made at the Campidoglio Observatory up to 1911. The mean apparent horizontal diameter, reduced to mean distance of the earth, shows a regular increase from 960″·70 in 1897 to a maximum of 961″·88 in 1908. It has decreased since then, with some oscillations. E. E. F. d'A.

**2128. Gallium in the Solar Chromosphere. S. Iimori.** *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers,* 10. *pp.* 1–4, *Feb.* 15, 1929. *Supplement. In English.*

In connection with a spectroscopic examination of gallium obtained from the mineral catlinite, the author gives a table of the lines of gallium observed by him, by Exner and Haschek, and by Papish and Holt. He compares the wave-lengths with those of certain solar lines taken from Rowland's table, some of which have been assigned to Fe, Mn, Ti and Al, and points out that lines can be found in the solar spectrum quite near to each of the gallium lines given by Exner and Haschek. Suggests a search in the ultra-violet region of the solar spectrum for known gallium lines. H. N. A.

**2129. Moon and Radioactivity. V. S. Forbes.** *Geolog. Mag.* 66. *pp.* 57–66, *Feb.*, 1929.

The author considers that the moon's density supports the view that it broke away from the earth's sialsphere and carried off enough sima to give a density of 3·46. Radioactivity will be greater in the sial, and this by generating heat, which cannot escape by the means Joly advocates for the earth, gives rise to violent eruptions. The moon's surface indicates this action, for otherwise the large temperature range and abrupt changes would cause expansion and contraction with consequent flattening of the surface. By this means the existence of the lines of craters, the lunar seas or maria as lava outpourings, the formation of anticlinal folds by pressure on the weaker parts and of the rift-valleys by faulting, can all be explained. R. S. R.

**2130. Rotation Period of Venus. R. Jarry-Desloges.** *Comptes Rendus,* 188. *p.* 832, *March* 11, 1929.

Errata in author's former paper [see Abstract 1487 (1929)]: *for* 22 h. 31 m. *read* 22 h. 21 m. (page 1131, line 28) and *for* 23 h. 53 m. *read* 22 h. 53 m. (page 1131, line 34). A. S. D. M.

**2131. Origin of Planets and Formation of Worlds. A. Véronnet.** *Comptes Rendus,* 188. *pp.* 550–552, *Feb.* 18, 1929.

Two theorems, deduced from more general ones, allow a mathematical explanation without any hypothesis of the two facts considered to be fundamental by Poincaré and Laplace, and give the first two stages in the evolution of the solar system. (1) The kinetic moment of an isolated system being invariable, the moment of rotation of the solar system can only be explained by external perturbing systems, and this perturbation must have been at the epoch of formation and condensation of the elements. (2) The rotation of a solid sphere in a moving medium is given in direction and magnitude by the whirling of motions at this point, and this rotation is zero only if the variation of rotation speed of the particles in the medium follows the law $\omega r^2$ = const. The author also considers the formation of stars and systems of stars. He concludes that a cluster, before attaining the steady state, must lose in heat the half of its energy of formation, and that parallel streams are clusters near the epoch of their formation and far from a steady state, but that planetary systems are in a state of stable equilibrium. A. S. D. M.

**2132. Equilibrium Forms of a Heterogeneous Fluid Mass. R. Wavre.** *Comptes Rendus*, 188. *pp.* 438–440, *Feb.* 4, 1929.

The equilibrium of a stratified rotating fluid mass is briefly discussed, the treatment being based on a theory developed in previous papers [see *Commentaria Mathematica Helvetica*, 1929, I, p. 3, and Abstract 865 (1928)]. J. S. G. T.

**2133. Photographic Absolute Magnitudes of Nuclei of Planetary Nebulæ. B. P. Gerasimovič.** *Harvard Coll. Obs., Bull. No.* 864. *pp.* 9–14, *Feb.* 1, 1929.

The central stars in planetary nebulæ are very peculiar, and it is of importance to determine their distances and absolute magnitudes. The problem is here attacked in four new and independent ways: (1) the elevation of the sun above the galactic plane having been recently determined, it is used as a basis for finding the mean latitude and mean distance of planetaries, and the absolute magnitude of 52 nuclei is then deduced from this and their photographic magnitudes; (2) the magnitude is derived from the galactic rotation of the planetaries; (3) from a comparison with novæ at the nebular stage; and (4) from the mean parallax of planetaries as derived from their tangential and radial velocities. These four determinations agree quite closely. The mean distance is found to be 790 parsecs, which corresponds with a parallax of 0″·0013, the mean apparent magnitude is 14·0, and the best value of the mean absolute magnitude is + 4·9. The large parallaxes found by van Maanen are probably due to a systematic error introduced by the selection of planetaries in his programme. It is important to remark that both the parallax and the galactic latitude of planetaries are the same as those of O stars. M. A. E.

**2134. Distribution of Stars in Space. A. Pannekoek.** *K. Akad. Amsterdam, Proc.* 32. 1. *pp.* 1–14, 1929.

Kapteyn showed that the distances of A and B stars may be determined without any great error by assuming for each star the mean absolute magnitude of the sub-class to which it belongs; and the completion of the Henry Draper Catalogue, which contains spectra and magnitudes of all stars down to the 8–9th magnitude, makes it possible to apply this method widely. By this means it is found that B stars show a strong tendency to cluster into groups separated by spaces almost empty of this class of stars, and the distances of the groups have been determined. The A stars, on the contrary, are dispersed everywhere throughout the galaxy, though they show a higher density in some parts, either mingling in the B groups or forming condensations without any intermixture of B stars. Giant K stars have a distribution of their own, in general independent of the distribution of A and B stars, but in some instances coinciding with groups of A where there are no B stars. This fact suggests that there may be two different types of stellar development, represented by these two types of stellar agglomeration, *viz.*, the A and B, and the A and K groups. It is evident that the stars surrounding our sun cannot be considered as a simple local cluster, but as a number of separate larger or smaller clusters, which probably have no more connection with one another than with the more remote groups; and each cluster has its own orbit round the centre of the galactic system as part of the general rotation discovered by Oort.

M. A. E.

**2135. Study of Variable Star W Sagittarii. G. Tiercy.** *Arch. des Sciences*, 11. *pp*. 15–34, *Jan.–Feb.*, 1929.

Twenty-one " Capelli-blu " plates taken between June 9 and August 30, 1927, have been used with methods similar to previous studies by the author. In the light-curve his limiting magnitudes ($4^{m}\cdot75$–$5^{m}\cdot85$), furnished by direct photometric measures, are nearer those of Chandler than of Pickering; the secondary undulation is accentuated, but this may be due to the use of three rather poor plates. The phase of minimum light ($5^{d}\cdot11$) accords with Voûte's and Pickering's values rather than with Prager's. The temperature, $T_1$, of the reversing layer at maximum light is about 7600°. The mean value of the radius (R) is 10,509,600 km. The pulsation curve is more regular than the light curve, but is not so symmetrical as those of SU Cassiopeiæ, T Vulpeculæ and X Sagittarii; like them it remains for a longer period with large R values than with small. For the colour index [see Abstract 1103 (1929)] he uses the formulæ $T(I-\alpha)=7200$; $0\cdot819\,I=\log R+0\cdot2\,M_{\nu}+0\cdot819\,\alpha-(C_{\nu}-x_{\nu})\,.\,5^{-1}$ where $\alpha=-\log[3\cdot77+0\cdot08\,s(3/4)^{(s-5)/5}$; $C_{\nu}+x_{\nu}=-(1\cdot26)\,.\,10^{-0\cdot04437\,s}$ and $s$ is the number of spectral intervals between G5 and A (positive in this order). These formulæ hold good for types K0–A5 in all cases, and perhaps, by interpolation, to K5 and to $A_0$. He considers the variations of T and P, and finds that $I_{\text{max.}}$ corresponds to $T_{\text{min.}}$ and feeble pressure and $I_{\text{min.}}$ to $T_{\text{max.}}$ and greater pressure (about 0·003 atmospheres).

A. S. D. M.

**2136. Physical Properties of a Gaseous Substratum in the Galaxy. B. P. Gerasimovič and O. Struve.** *Astrophys. J.* 69. *pp*. 7–33, *Jan.*, 1929.

By means of the observed intensities of the detached $Ca^{+}$ lines in stars of various apparent magnitudes and the corresponding distances, the average absorption coefficient per cm. was found to be $\beta=1\cdot1\times10^{-22}$. Taking into consideration the probabilities of different electronic transitions for the $Ca^{+}$ atom, the interstellar density of $Ca^{+}$ is $\rho_{ca}{}^{+}=3\cdot6\times10^{-32}$. In order to compute the actual density of the interstellar gas, consisting of atoms of many elements in various states of ionisation, the ionising efficiency of the diluted radiation from all stars in space was computed. This yielded the relative concentration of Ca atoms in different states of ionisation. Making reasonable assumptions concerning the partial abundance of Ca in the gas, the total density turns out to be of the order of $10^{-26}$. These results were applied to Na, but the computed intensities relatively to the neighbouring portion of the continuous spectrum were found to be too small, which might be accounted for by an inaccuracy of the adopted value of the probability coefficients for D lines. The effect of nearby stars upon the general absorption was investigated but found to be negligible. Observational evidence does not favour the existence of condensations near the stars. The hypothesis of an interstellar substratum embodying the whole galactic system is the most satisfactory at present. This hypothetical substratum shares the rotational motion of the stars around a distant central mass in galactic longitude 325°.

AUTHORS.

## LIGHT.

**2137. Absorption of Ultra-Violet Radiation in Ozone. A. Läuchli.** *Zeits. f. Physik*, 53. 1–2. *pp.* 92–94, 1929.

New results are given for four methods described earlier [see Abstract 1134 (1929)]. These show remarkable scattering for $248\cdot 2\ \mu\mu$, but little for $253\cdot 7\ \mu\mu$. Further purification of the spectrum has no appreciable effect on the absorption coefficient for $253\cdot 7\ \mu\mu$. R. S. R.

**2138. Approximate Method for Calculating the Absorption of Optical Glass. A. A. Gerschun.** *Zeits. f. techn. Physik*, 10. 1. *pp.* 18–19, 1929.

Fresnel's reflection theory is applied to determine a simple approximate formula which can be used in connection with the Martens polarisation photometer for calculating the absorption in optical glass. Two numerical examples show that the formula gives results which are not more than about 2 % in error. A. W.

**2139. Laws of Colour. A. Klughardt.** *Zeits. f. techn. Physik*, 10. 3. *pp.* 101–103, 1929.

The author has established by another method the colour relations stated previously [see Abstract 2853 (1927)]. The characteristic numbers are given for wave-lengths between $3\cdot 90 \times 10^{-5}$ and $7\cdot 00 \times 10^{-5}$ cm., and equations are established in terms of this number and the primary colours which specify any other colour completely. A further proposal is made regarding the limits of saturation. R. S. R.

**2140. Threshold Intensity Values and Angle of Vision. F. Löhle.** *Zeits. f. Physik*, 54. 1–2. *pp.* 137–151, 1929.

The limiting intensity values for perception were determined by two observers for foveal and extra-foveal vision, with luminous discs, under angles of vision from $0\cdot 1'$ to 1° for foveal and 14° for extra-foveal vision. For angles of vision up to 10′, Riccò's law held good, both for foveal and extra-foveal vision. For angles from 2 to 7°, Piper's law held good. The results of other observers are compared. A. D.

**2141. Difference Threshold of the Eye for Small Angular Fields. I. Runge.** *Phys. Zeits.* 30. *pp.* 76–77, *Feb.* 1, 1929.

Various width slits were placed in front of the Lummer-Brodhun cube of a photometer-head in order to limit the angular field. The observable difference was found for several brightnesses. It was not found to vary with brightness as in the case of Karrer and Tyndall's results. F. S.

**2142. Metallic Reflection. M. Cossi.** *Accad. Sci. Torino, Atti*, 63. 11A–14A. *pp.* 287–292, 1927–1928.

The properties of the light reflected from a metallic mirror show a progressive change starting from a certain value of the thickness of the electrolytic deposit. For copper, nickel and silver these thicknesses are 2, 3 and 7 $\mathrm{m}\mu$ respectively. The minimum thicknesses corresponding to the compact metals are 58, 64 and 70 $\mathrm{m}\mu$ respectively. At the moment when the optical constants of the reflecting surface begin to show a difference the depositing current shows a 3 % increase. E. E. F. d'A.

**2143. Systems of Plane Reflecting Surfaces. T. Smith.** *Optical Soc., Trans.* 30. 2. *pp.* 68–78, 1928–1929.

An algebraic method is evolved of finding the coordinates of the image of any point and of the direction of the emergent portion of any given incident ray after reflection at any number of plane-reflecting surfaces. Systems of reflectors are classified according to the nature of the self-conjugate region of the field. A method of designing a system having any assigned properties is described. Suitable criteria are given to determine whether with a prismatic system the whole is non-dispersive, and whether total internal reflection takes place at any given surface; also the boundary conditions at each surface are found. The calculations are simple and free from any ambiguity of sign. AUTHOR.

**2144. Reflecting Systems for Image Inversion. T. Smith.** *Optical Soc., Trans.* 30. *pp.* 79–96, 1928–1929.

The method of investigating systems of plane reflectors described in another paper [see preceding Abstract] has been applied to determine how many optical surfaces are necessary in an inverting prism. Four surfaces involve oblique refraction into the prism whatever the number and order of the reflections. With five surfaces one form is possible with four reflections. All possible arrangements with six reflections at five surfaces are considered, and the application of the method to prisms with a greater number of reflections is illustrated. AUTHOR.

**2145. Multiple Reflection within a Symmetrical Optical Instrument. T. Smith.** *J.O.S.A. and R.S.I.* 18. *pp.* 75–81, *Feb.*, 1929.

The Gaussian constants of a symmetrical optical instrument are built up from those of its parts by matrix multiplication. The matrix method is employed to find the constants for light which has been reflected any number of times between two given surfaces of the instrument. The matrix is expressible as the sum of two parts, each consisting of the product of a trigonometrical function depending on the number of reflections and a matrix which is independent of this number. AUTHOR.

**2146. Plane Infinitely Conducting Grating. G. Jaffé and E. Fischer.** *Phys. Zeits.* 30. *pp.* 87–93, *Feb.* 1, 1929.

Jaffé (*Phys. Zeits.*, p. 578, 1921) developed a theory of refraction by an ideally conducting grating leading to a differential equation. In *Math. Ann. Jahrgang*, 1929, Fischer showed how to obtain certain numerical results. The present paper shows how to solve the differential equation by successive approximations. A. D.

**2147. Effective Representation of Non-Self-Illuminated Objects. M. Berek.** *Zeits. f. Physik*, 53. 7–8. *pp.* 483–493, 1929.

Develops, from a consideration of a law first stated by Verdet, the principal laws of the equivalence doctrine. Siedentopf's results [see Abstract 3211 (1928)], which led him to object to the equivalence doctrine and to make the assertion that the Abbe theory was the only satisfactory one, are also considered, and the errors of Siedentopf's assertions pointed out. The paper is entirely theoretical, although experimental results will be given in another contribution on the subject. R. C. F

**2148. Relations between Field Illumination and Optimum Visual Field for Observational Instruments. L. C. Martin and T. C. Richards.** *Optical Soc., Trans.* 30. 1. *pp.* 22–31; *Disc.*, 31–32, 1929.

The paper describes some experiments based on the application of the results of recent studies on " spatial induction " in vision to determine the conditions governing the optimum size of visual field under certain conditions. The results have a bearing on recent efforts greatly to enlarge the fields of view of binoculars, indicating that small fields are better under certain conditions. AUTHORS.

**2149. Lenses and Equipment for Ultra-Violet Photography. J. W. Gifford.** *Optical Soc., Trans.* 30. 1. *pp.* 34–40, 1929.

A description is given of the type of photographic doublet generally known as rapid rectilinear, in which (1) fluorite and quartz, (2) quartz and calcite are substituted for the ordinary crown and flint glasses. These doublets are therefore more or less transparent to the ultra-violet as well as to the visual spectrum. Corresponding lists of focal lengths for twenty-one wave-lengths are given, as well as the radii, thicknesses, etc., for construction. A cement transparent to the ultra-violet for use with these lenses is described, and photographs of the spectra transmitted by certain light filters are given. AUTHOR.

**2150. Lenses. C. Beck.** *Journ. Sci. Instruments*, 6. *pp.* 40–49, *Feb.*, 1929.

An informing *résumé* as to the elementary aspects of the characteristics of lenses. The author urges that in the elementary exposition attention should be paid, not only to the central rays (the study of conjugate points) and the image formed by the non-axial rays, but also to tracing out one complete bundle of light from the marginal point of the object through the entire system and past the final image. He gives examples of the utility of this. A. D.

**2151. Combination of a Fabry-Perot Interferometer with a Spectroheliograph for Determining Solar Velocities and Rotation of the Sun. W. E. Williams.** *Zeits. f. Physik*, 53. 7–8. *pp.* 542–547, 1929.

The first part of the paper describes the formation and character of the image formed by a Fabry-Perot interferometer and a Lummer-Gehrcke plate when placed between a collimating lens and a telescope, an illuminated slit being placed in the focal plane of the collimating lens. From an expression for the energy transmitted the author deduces that a point-for-point correspondence can be obtained between image and object. The conclusions were experimentally verified by the use of a crossed slit. Buisson, Fabry and Bourget [see Abstract 49 (1915)] used this point-to-point method with a Fabry-Perot interferometer for the determination of the radial velocity of Orion's nebula. The author places a Fabry-Perot interferometer behind the collimator of a spectroheliograph so that it moves with it, and only the photographic plate and the sun's image remain fixed. Fabry-Perot rings are obtained, whose relative positions are not altered if the same wave-length is employed for the whole image of the sun. When the second slit of the spectroheliograph is wider than the spectral line, the interferometer shows the sun's rotation. The effect of local changes is also shown in the figures of the bands given in the paper. The formation and theory of these is discussed. The paper is completed with an account of the considerable practical difficulties encountered in preparing the plates of the interferometer, which were made from fused quartz in order to minimise the effects of temperature.

T. B.

**2152. Improving the Performance of Interference Spectroscopes. E. Lau.** *Zeits. f. Instrumentenk.* 49. *pp.* 57–63, *Feb.*, 1929.

The author has already stated [see Abstract 892 (1928)] that silvering the Lummer-Gehrcke plate improves the performance of this instrument, but others have said that the improvement only occurs in the red part of the spectrum. From results of a comparison of two spectrograms, between the limits 4800 Å. and 3600 Å., one taken using a silvered plate and the other using a normal plate, it is shown that an improvement is definitely effected by the silvering, especially for the rays which have undergone the largest number of reflections. Curved glass plates can be used instead of flat ones, and it is shown that improvements occur by subjecting the curved plate to a definite strain. Owing to the large number of reflections which certain of the rays undergo, there is naturally a decrease in intensity of these rays, and two methods for correcting this decrease are given. For the Fabry-Perotétalon kathode sputtering is shown to be the best method for the necessary silvering. The method of doing this is shown, and, finally, after a brief discussion of other peculiarities of the étalon, the difference in the operation of the Lummer-Gehrcke plate and the Fabry-Perotétalon is given. R. C. F.

**2153. Small Prism. Hamann.** *Zeits. f. Instrumentenk.* 49. *pp.* 79–90, *Feb., and pp.* 109–139, *March*, 1929.

Diagrams and details are given of a new type of instrument employed on survey work. The theory of its action and its advantages in comparison with former types are discussed. R. S. R.

**2154. Aberration Effect on Straight Line Reproduction. A. Buxton.** *Phil. Mag.* 7. *pp.* 441–452, *March*, 1929.

The theory of the reproduction of luminous points and lines in a symmetrical optical system depends upon diffraction and the aberration residuals in the system. The author establishes first the general relation for the position of the first-order image plane and the equations for the third-order aberrations. The separate effects of the aberrations on the luminous line integrals are then established for distortion, spherical aberration, curvature and astigmatism and coma. The paper is wholly mathematical. R. S. R.

**2155. Formation of Interference Bands in a Light Beam in Passing Over the Disturbed Surface of a Liquid. Z. Wolkowa.** *Zeits. f. Physik*, 53. 9–10. *pp.* 708–718, 1929.

A parallel light bundle is passed horizontally through a cell with parallel sides and half-filled with a liquid. The outgoing light is received by a telescope, in the focal plane of which an image of the collimator slit is normally observed. The rays forming this image have passed through the cell parallel to the liquid surface, some through the liquid and some through the air above. On disturbing the liquid momentarily and then observing in the telescope, two series of interference bands are seen, spreading out on either side of the original slit image. These are shown to arise owing to a variation in the refractive index in the liquid just under the surface and in the air just above, following the disturbance. The bands are transient and close in on the undeviated image in a period varying from one to three minutes, depending on the liquid and the character of the initial disturbance. Experiments were made with benzene, alcohol, ether and water. A theory of the effect is developed, based on the idea that the disturbance "explodes" the particles forming the surface layer and that these particles form a layer just outside the liquid surface, and give rise in this way to the variations in refractive index required. The falling-in of the bands is regarded as due to the diffusion of these particles back into the liquid surface. W. S. S.

**2156. Effect of Environment on Photographic Sensitivity. S. E. Sheppard and E. P. Wightman.** *Kodak Research Lab. Comm. No.* 349. *Phot. J.* 69. *pp.* 22–35; *Disc.*, 35–36, *Jan., and pp.* 134–141, *March*, 1929.

Describes in the first part of the paper the results of an investigation of the reversible *p*H effect on the speed of emulsions as observed by Rawling [see Abstracts 988 and 1347 (1927)]. A confirmation of Rawling's results is obtained in certain cases, especially with regard to finished plates. Only small and uncertain changes of speed with *p*H were obtained on adjustment of *p*H, by bathing the plates, up to and during exposure, whilst remelting the emulsion and adjusting the *p*H values in the melt did not affect the results. Greater changes were produced by the bathing treatment for freshly prepared emulsions, and these could be further increased by adjusting the liquid emulsion before coating. These changes, however, could not definitely be shown not to be due to residual sensitisation by irreversible chemical change. With an ammonia emulsion, in which the possibility of "residual sulphide sensitivity" was even greater, somewhat greater effects still were obtained. Emulsions made with "inert" gelatine showed a low speed irrespective of the final *p*H, but the same emulsion made with gelatine activated by thiourea showed a much higher speed capacity. Generally, however, the speeds of both these emulsions were dependent upon the final *p*H value just before and at exposure. A brief review of Rawling's results is given and theories of the cause of the effect and also of its variations are discussed. In the *Discussion*, in which **T. S. Price, S. O. Rawling, Dickins, W. Clark, O. Bloch** and **F. F. Renwick** took part, **S. O. Rawling** queried certain of the authors' conclusions, showing that experimental results he had obtained were not in agreement with these conclusions; **F. F. Renwick** queried the use of a finished plate, bathing it, and then expecting it to behave normally. This might account for differences in results obtained between dried plates and emulsions.

In the second part the action of certain neutral salts on the formation of the latent image is examined. No effect was found for potassium citrate, whilst potassium chloride only produced a slight effect upon developability. With potassium bromide a marked reduction in sensitivity was observed when the salt was present during exposure. No acceleration of the latent image formation was obtained for high-speed plates with acid silver nitrate. The results are discussed in terms of the transfer of electrons from the bromide ions to the silver ions of the lattice. R. C. F.

**2157. Colour Problems in Photo-Engraving. A. J. Bull.** *Journ. Sci. Instruments*, 6. *pp.* 50–51, *Feb.*, 1929.

Discourse at the 19th Annual Exhibition of the Physical and Optical Societies. A. D.

**2158. Infra-Red Photography. M. Czerny.** *Zeits. f. Physik*, 53. 1–2. *pp.* 1–12, 1929.

The processes in use at the present time for photography in the infra-red are only suitable up to wave-lengths of approximately 2 $\mu$. From a discussion of the physical peculiarities of any increase in this maximum, it is shown that the dark radiation at room-temperature will play such an important rôle as to make any extension difficult. The author describes a method which is not affected by this difficulty. A layer of naphthaline is deposited on a thin celluloid membrane and enclosed in a vessel which is filled with a saturated naphthalene vapour. This infra-red radiation is received by this vessel, and transferred into heat by absorption. This evaporates the naphthalene from the portion receiving the radiation, and it is deposited on unradiated parts. Thus, the parts which receive the radiation become much thinner than the surrounding deposits and are easily observed. Camphor and similar substances can be used, but further difficulties then appear. Results obtained, using the method developed, show this to be quite practical. The limits and possibilities of the process are also discussed. R. C. F.

**2159. Quantitative Examination of Certain Photographic Effects. H. Tollert.** *Zeits. f. phys. Chem.* 140. *Abt. A.* 5–6. *pp.* 355–378, *Feb.*, 1929.

The first part of the paper deals with a comparison of results obtained for the quantity of photolytically formed silver with that obtained by direct development, for a particular emulsion known as the " Lippmann " emulsion. Details of this emulsion are given and its qualities examined, whilst a titration method is used for the estimation of the values of the two types of silver. It is found that in the region of solarisation the quantity of silver formed photolytically rapidly increases with increasing illumination. The quantity of silver obtained by development, however, rises steadily to a maximum and then decreases, and this phenomenon also occurs in the density of this developed silver. In the second part of the paper the results of some sensitisation experiments are given. An emulsion sensitised for green light by means of erythrosine is found to contain the number of photolytically formed silver atoms up to 64 times the number of dye molecules adsorbed in the silver bromide. From three different emulsions, one of which was treated with a sensitiser, one with a desensitiser, and one with a bromide acceptor, it is concluded that the density of the exposed parts do not give any indication of the value of the photolytically-formed silver. The Herschel effect is dealt with in the third part of the paper, and it is shown to be caused by a variation in the structure of the emulsion. It can be conceived as a variation in the dispersion of the photolytically-formed silver. The ratio of the action of the energy in red light to that in blue light is calculated, and $2 \cdot 2 \times 10^6$ quanta of energy emitted by red light are found to produce the same blackening as 1 quantum of energy emitted by blue light. If, however, the energy in the blue which produces a definite blackening be compared with that required in the red to bleach this blackening, it is found that 1 quantum of energy in the blue corresponds to a mean value of $10^{9\pm1}$ quanta of energy emitted in the red. R. C. F.

**2160. Photographic Bleaching Reactions. Lüppo-Cramer.** *Phot. Indust.* 27. *pp.* 129–131, *Feb.* 6, 1929.

Briefly discusses the results of some of the present author's latest publications on the causes of such bleaching reactions—Herschel effect—in Satrox gaslight paper and impregnated diapositive plates. [See also Abstracts 2878 (1927) and 2686 (1928).] R. C. F.

**2161. Determination of Lower Limiting Gradient. F. Formstecher.** *Phot. Indust.* 27. *pp.* 237–238, *Feb.* 27, 1929.

Develops a simple formula in which the lower limiting gradient of the reproduction is shown to be inversely proportional to the Goldberg constant. A comparison of the theoretically obtained values with those observed by Jones [see Abstract 2879 (1927)] is given and shows good agreement. R. C. F.

**2162. Photographic Printing with Diazo Compounds. J. M. Eder.** *Phot. Indust.* 27. *pp.* 271–272, *March* 6, *and pp.* 296–298, *March* 13, 1929.

Discusses in detail the results of the latest work on the subject of diazotypes, and considers mainly the chemistry of the various processes, including development. The latest types manufactured by van der Grinten are chiefly dealt with, and the author considers the cases of diazotype coatings with pseudo-components, and the integral light pictures with diazosulphonate, also produced by the same company. R. C. F.

**2163. Theory of the Silver Nucleus. R. E. Liesegang.** *Phot. Indust.* 27. *p.* 349, *March* 27, 1929.

Advances a new theory with regard to the structure of the silver nucleus in which the author suggests that, as with the silver bromide lattice, the metallic silver lattice is formed of two types of ions. One of the types is a positively charged ion, with an electron too few, whilst the other one is a negatively charged ion, with 7 electrons extra in the outer orbit. Proof of this theory is offered from a consideration of some of the latest results of other investigators. R. C. F.

**2164. New Preserving Compound for the Photographic Industry. W. Leszynski.** *Phot. Indust.* 27. *pp.* 426–427, *April* 17, 1929.

Describes results of experiments carried out in order to ascertain whether a methyl ester " nipagin " is suitable as a preserving compound. For this to be so, there must be no destructive action on the photographic properties of the emulsion, and this is shown to be fulfilled by a comparison between preserved and unpreserved emulsions. Preservation appears to be at its best when the " nipagin " content of the plate is 0·06 %, but values ranging from 0·03 % to 0·08 % can be used quite satisfactorily. R. C. F.

**2165. Goldberg Spectrodensograph. H. Schering.** *Phot. Indust.* 27. *pp.* 454–457, *April* 24, 1929.

Describes the construction and use of a new type of Goldberg densograph in which obtaining absorption curves is simplified. The original apparatus was suitable for obtaining transmission and reflection factors of materials for any wave-length whatsoever, and also for the absorption curves of filters from spectrum photographs. In the new model absorption curves can be obtained directly, for not only can the filter be incorporated in the instrument, but the curves are traced out on a sheet of paper. The apparatus consists of a monochromator in which the spectrum obtained is split into two halves, the top one passing through the filter and the bottom half through a neutral wedge before entering the photometer. In the photometer, after passing through a prism, the position of the two halves of the spectrum is reversed, so that the eye sees them with the part which has passed through the neutral wedge above, but in close juxtaposition with, that which has passed through the filter. The two prisms are coupled together, and the registering device is actuated by links from the monochromator prism and the neutral wedge. R. C. F.

**2166. Measurement of Polish. R. Kempf and J. Flügge.** *Zeits. f. Instrumentenk.* 49. *pp.* 1–25, *Jan.*, 1929.

Forms an extended and critical survey of the whole subject of polish, its physical cause, and the appearances to which it gives rise. The various formulæ which have been proposed to express the degree of polish of a surface are examined. They depend on the following quantities: $I_a$, the intensity of the incident light, $I_r$, the intensity of the specularly reflected light, and $I_d$, the intensity of the diffusely reflected light measured in some specified direction. The first definition of the degree of polish, G, is $(I_r + I_d)/I_a$. This, however, has the disadvantage that G is made to depend on the reflection factor of the surface as well as on the state of its polish. The same objection applies to the definition $G = I_r/I_a$ unless a factor $k$ is introduced such that $G = 1$ in the direction for which $I_r$ is a maximum. The third definition is $G = (I_r + I_d)/I_d$, or some modification of this expression such as $G - 1$ or $G = I_r/(I_r + I_d)$. This form of definition is examined in some detail, and it is applied to the results of measurements made on certain surfaces which would be described as matt, semi-matt or polished. The effect of the absolute reflection factor is also investigated. In the third section of the paper are given the results of an extended series of measurements carried out with translucent diffusing materials. In particular, the effect of the background (white or black) on the reflection characteristics of piles of plates of such materials is demonstrated, and a formula is deduced $(G = \log (I_r + I_d) - \log I_d)$ for the expression of the results. A further paper is promised. J. W. T. W.

**2167. Polarised Fluorescence. Elspeth Hakenbeck.** *Ann. d. Physik*, 1. 4. *pp.* 457–496, *Feb.* 25, 1929.

An investigation on the polarisation of the fluorescence of fluorescein in glycerine and glycerine-water solutions, to test an extension of Perrin's theory [see Abstract 1018 (1926)]. The formula of Wawilow and Lewschin [see Abstract 1847 (1923)] connecting the degree of polarisation with the direction of vibration of the incident light was confirmed experimentally. A determination of the degree of polarisation as a function of the viscosity of the solution gave by the Perrin theory the molecular radius, which was in general agreement with that obtained from other sources. The absorption law of Beer does not hold. The general conclusion is reached from the observations that the present theories of the mechanism of this type of fluorescence do not account for the facts. J. E.

**2168. Resonance by Collision in Fluorescence and Chemiluminescence. H. Beutler and B. Josephy.** *Zeits. f. Physik*, 53. 11–12. *pp.* 747–765, 1929.

In the collision of an excited atom with a normal atom most of the excitation energy is transferred from the atom collided with, without a change in transformation energy. Using a sodium-mercury vapour mixture and exciting it so that a radiation is emitted containing the line 2536·52 Å., it is shown that sufficient energy is imparted to the sodium vapour to bring about the change $1^2S \rightarrow 7^2S$. The energy required for this corresponds to that given out by the transformation $2^3P_1 \rightarrow 1^1S_0$ in mercury, which gives rise to the emission line 2536·52 Å. By mixing the sodium-mercury vapour with nitrogen and converting the $2^3P_1$ mercury atoms to $2^3P_0$ mercury atoms, the energy emitted by the transformation of the mercury atoms from $2^3P_0 \rightarrow 1^1S_0$ is comparable with that required to change the state of the sodium atom from $1^2S \rightarrow 5^2S$. This preferred transition of the excitation energy is observed, in chemiluminescence, for several reactions of dilute gases on the same vapours. This is to be expected, because in the two phenomena similar elementary processes are taking place. In the chemiluminescence of gas reactions the units excited can be either atoms or molecules. Values of the transition probabilities obtained from the energy of the nascent particles and the terms stimulated are found to agree with those calculated from thermo-statistical considerations of the excitation. R. C. F.

**2169. Ultra-Violet Radiation from Bodies Subjected to γ-Rays. L. Mallet.** *Comptes Rendus*, 188. *pp.* 445–447, *Feb.* 4, 1929.

Previous investigations [see Abstract 3009 (1928)] have been repeated with a spectrograph in which glass has been entirely replaced by quartz or rock-salt. The prisms used are of quartz and water. In this way a spectrum 22 mm. long was obtained between 4360 and 2400 Å. With γ-rays from 250 mg. of radium sulphate and an exposure of 4–8 days, in the case of water a continuous spectrum reaching up to 2500 Å. was obtained, but it is considered probable that further improvement in the apparatus would extend this. Carbon disulphide gave a continuous spectrum, which, however, ended abruptly at 3959 Å. C. A. S.

**2170. Geometrical Radiation Problem. E. A. Milne.** *Phil. Mag.* 7. *pp.* 273–276, *Feb.*, 1929.

This is a similar problem to that of which the solution was given by L. F. Richardson for the radiation through a pair of parallel square apertures [see Abstract 804 (1929)]. The present paper deals with circular apertures. Let $a$, $b$, be the radii of two circular apertures whose planes are perpendicular to the line joining their centres, whose distance apart is $l$. Then if I is the intensity of radiation, it is shown that the amount of radiant energy passing through the first aperture and reaching the second is, per second, $R = \frac{1}{2}\pi^2 I[a^2 + b^2 + l^2 - \{(a^2 + b^2 + l^2)^2 - 4a^2b^2\}^{\frac{1}{2}}]$. If $a = b$, it is shown that the radiation incident on the far face of the circular cylinder formed by the two apertures is reduced by the presence of the cylinder in the ratio of $\tan^2 \frac{1}{2}\theta : 1$, where $\theta$ is the semi-vertical angle of the cone outside which no radiation incident on one aperture can reach the other. T. B.

**2171. Uniformly Diffused Light through Two Apertures. A. Gerschun.** *Phil. Mag.* 7. *p.* 419, *Feb.*, 1929.

L. F. Richardson showed [see Abstract 804 (1929)] that the amount of light, uniformly diffused with brightness I, that will go in series through two apertures forming opposite faces of a cube of edge $l$ is $\phi = (0\cdot 6278 \pm 0\cdot 0001)l^2\mathrm{I}$. It is pointed out that this case has an accurate solution in the form $\phi = (4\sqrt{2} \operatorname{arc\,tan} 1/\sqrt{2} - \pi + \log 4/3)\, l^2\mathrm{I}$. T. B.

**2172. Analysis of the First Spark Spectrum of Sulphur. D. K. Bhattacharyya.** *Roy. Soc., Proc.* 122. *pp.* 416–429, *Feb.* 4, 1929.

By applying the method of horizontal comparison recently described by Saha and Majumdar [see Abstract 176 (1929)] the principal groups of visible lines of $S^+$ due to the transition $2M_2$ $(N_{\underline{1}} \leftarrow N_2)$ were located approximately as follows: $^4P - {}^4D$ at 18,000; $^4P - {}^4\bar{P}$ at 20,000; $^4P - {}^4S$ at 21,000. Comparison with available measurements confirmed strong groups of lines in these regions. The two strongest lines $^4P_3 - {}^4D_4$ and $^4P_3 - {}^4\bar{P}_3$ were then identified as the two $S^+$ lines identified by Keeler in the spectrogram of Rigel. Using these clues the classification of some 50 lines in the range λ3842 to λ5646 is accomplished. Some preliminary measurements of the lines in the red and infra-red are given, made with a view to the identification of the doublet spectrum of $S^+$. *Note added November* 26, 1928. Comments on a paper by Ingram, who obtains a classification of the lines of $S^+$ in agreement with that of the author. W. S. S.

**2173. Spark Spectrum of Iodine. L. and E. Bloch.** *Ann. de Physique*, 11. *pp.* 141–166, *Feb.*, 1919.

The spectrum was excited by an oscillating discharge in an electrodeless tube. The wave-lengths measured between 7350 Å. and 2220 Å. are tabulated. Four stages of ionisation have been observed as compared to three in the cases of Cl and Br [see Abstract 639 (1928)]. The discharge was accompanied by a violet fluorescence similar to that which has been photographed in the cases of Br and Cl. F. S.

**2174. Magneto-Optic Determination of Intensities of the Two First Members of the Potassium Chief Series and Vapour Pressure of Potassium. J. Weiler.** *Ann. d. Physik*, 1. 3. *pp.* 361–399, *Feb.* 9, 1929.

By the measurement of the anomalous magneto-rotation in the neighbourhood of the two first chief series members of potassium the absolute number of the dispersion electrons in non-luminous K vapour was determined. It is characteristic for the intensity of the absorption lines. As for the first doublet (7699 Å.U., 7665 Å.U.) so for the second doublet (4047 Å.U., 4044 Å.U.). Within limits of error of ± 4 % the intensity ratio is found to be 2:1, independent of the temperature within the interval investigated, 156° C. to 355° C. The intensity ratio of the red to the violet member is 98·5:1 ± 5 %, in the interval examined − 253° C. to 296° C., likewise independent of the temperature. The assumption that the number of the dispersion electrons distributed in the first doublet is equal to the number of the vapour atoms generally present affords from the measurements the vapour pressure formula determined by the method of least squares: $\log p\,.\,T = -\dfrac{20{,}590}{4\cdot 571\,.\,T} + 10\cdot 133$. The vapour pressure formula determined by the boiling point and the author's measurement point, $\log p\,.\,T = -\dfrac{21{,}100}{4\cdot 571\,.\,T} + 10\cdot 37$, is still in agreement

with the measurements. Kröner's measurements of the vapour pressure (250° C. – 400° C.) agree well within reasonable limits of observational errors.
J. J. S.

**2175. D-Terms of Potassium and Sodium. A. Ferchmin and S. Frisch.** *Zeits. f. Physik,* 53. 5–6. *pp.* 326–330, 1929.

The potassium lines $2^2P_{3/2} - 5^2D$, λ5832, and $2^2P_{3/2} - 6^2D$, λ5360, were examined by an echelon grating and found to have weak satellites on the short wave-length side. These are due to the D-term being double, and its components are inverted. The separation of the components of $5^2D$ is $0 \cdot 52$ cm.$^{-1}$, and of $6^2D$, $0 \cdot 24$ cm.$^{-1}$. The sodium line $2^2P_{3/2} - 4^2D$, λ5688, was investigated with the echelon grating and a large Lummer plate. Even with this resolving power the line appeared single. The components cannot be farther apart than $0 \cdot 1$ cm.$^{-1}$. A. C. M.

**2176. Second Spark Spectrum of Potassium KIII. T. L. de Bruin.** *Zeits. f. Physik,* 53. 9–10. *pp.* 658–664, 1929.

Starting from the known structures of the chlorine arc spectrum ClI, and the first argon spark spectrum ArII, the author has identified, using the law of irregular and regular doublets, the principal terms of the second spark spectrum of potassium KIII. A doublet and quartet system has been found. Tables show the term combinations of twenty-seven KIII lines, and the term values and term differences of ClI, ArII and KIII. A diagram shows the Moseley graphs for the three " elements," and another the analogy found in the term differences of the seven electron systems investigated. These include KIII, ArII, ClI, NeII and FeI. H. N. A.

**2177. Flutings in Absorption Spectrum of a Mixture of Mercury and Cadmium Vapours. J. G. Winans.** *Phil. Mag.* 7. *pp.* 565–566, *March,* 1929.

The wave-lengths and frequencies of the new flutings are given in a table; they are diffuse and difficult to measure. Similar flutings have been observed in Hg, Cd and Zn by Rayleigh and Mohler and Moore. Walter and Barrett think they may be due to impurities. They are, however, most likely due to HgCd molecules. H. N. A.

**2178. Absorption Spectra of Tin, Silver and Manganese Vapours. R. G. Loyarte and A. T. Williams.** *Phys. Zeits.* 30. *pp.* 68–75, *Feb.* 1, 1929.

In this continuation of previous work [see Abstract 1280 (1928)] the spectrum between 5500 Å. and 2140 Å. was photographed against the continuous hydrogen spectrum by a quartz spectrograph. The metals were vaporised in an electric oven at temperature between 1200° and 2200° C. The results for tin and manganese agree with those of Zumstein and McLennan, while those for silver are to be reconsidered, lines belonging to the ionised atom having been observed. The results are in agreement with Hund's conclusions regarding the deeper levels of the atom. The equation $N'/N = e^{-E/RT}$, giving the proportion of excited atoms, is found to hold for tin. F. S.

**2179. Band Absorption Spectrum of Iodine. M. Kimura and M. Miyanishi.** *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 176. *pp.* 33–42, *Feb.* 10, 1929. *In English.*

Following Oldenberg's observation [see Abstract 514 (1924)] of a band spectrum due to excitation by light in the region of λ1900, the absorption spectrum was investigated using a hydrogen discharge tube as source. The iodine vapour was contained in a fused silica tube provided with a side tube containing crystals, and each provided with a separate heater. The bands were photographed with a small quartz spectrograph. The observed lines and deduced vibrational levels are tabulated. F. S.

**2180. Absorption Spectrum of $CS_2$ in the Near Ultra-Violet. E. D. Wilson.** *Astrophys. J.* 69. *pp.* 34–42, *Jan.*, 1929.

The absorption spectrum of carbon disulphide in the near ultra-violet has been photographed under varied experimental conditions in such a manner as to exhibit a rather complete development of the band system over the range of wave-lengths λ2900–λ3800. The wave-lengths of about 650 absorption lines have been measured, and their relative intensities estimated from photometric curves. Certain regularities of structure in the band system are pointed out, and some series with constant differences in frequency recorded. AUTHOR.

**2181. Absorption Measurements in the Cæsium Principal Series; Broadening due to the Pressure of the Absorbing Vapour. F. Waibel.** *Zeits. f. Physik*, 53. 7–8. *pp.* 459–482, 1929.

Light from an arc lamp was passed through calsium vapour at different pressures (10 to 32 mm. Hg) and the intensity distributions in the absorption lines corresponding to the higher (fifth to fourteenth) members of the principal series were determined photographically. The broadening of the lines due to the pressure of the calsium vapour itself could in this way be evaluated, and was shown to correspond to the relation: half-band-width and square root of the calsium vapour density. A marked asymmetry in the measured absorption lines was observed for the lower members of the series, which gradually vanished above the tenth member. Of the two components of each line, the stronger component gave a half-band-width considerably greater than that of the weaker. The absolute magnitude of the broadening due to the calsium vapour is shown to be 200 times that produced by an inactive gas of the same density. From the results were also obtained the relative total absorptions of the fifth to the four-tenth lines, and the relative absorptions of the doublet components for the fifth and sixth members. W. S. S.

**2182. Raman Effect in Quartz. M. Czerny.** *Zeits. f. Physik*, 53, 5–6. *pp.* 317–325, 1929.

Assuming that each Raman line corresponds to a molecular absorption band in the infra-red, it is possible to predict the selective absorptions in that region. The region of the infra-red beyond 30 has been investigated by the author, to search for the absorptions to be expected at 38, 48 and 80 μ respectively. The first and last were found, but not the one at 48 μ. Also the intensities of the absorptions had not the same relative values as in the case of the Raman lines. A. C. M.

**2183. Residual Rays and Raman Effect. C. Schaefer.** *Zeits. f. Physik*, 54. 1–2. *pp.* 153–154, 1929.

Various observers have failed to find the Raman line in rock-salt corresponding to the residual ray frequency at about 50 μ. The author also has failed to find the analogous lines in the cases of the fluorides of lithium and sodium. It is suggested that there may be a theoretical explanation of the non-appearance as follows. The Raman effect is to

be connected with a non-harmonic vibration, so that there will be terms of the third and higher orders in the expression for the potential energy. The third order term will usually be stronger than that of the fourth order, implying an asymmetrical vibration. Suppose that the residual ray frequencies above referred to correspond to the mutual vibration of the two ionic lattices. But in these substances each ion is connected with six ions of the opposite sign, symmetrically, so that the vibration may be non-harmonic, but not asymmetrical. Thus, in the expression for the potential energy the third-order term will drop out, leaving at the most a weaker fourth. Therefore, the Raman lines corresponding to the residual ray frequencies will be of a lower order of intensity than the infra-red frequencies corresponding to asymmetrical vibrations.
A. C. M.

**2184. Intensities in the He Spectrum as Functions of Pressure and Electron Velocity. (Miss) M. G. Peteri and W. Elenbaas.** *Zeits. f. Physik*, 54. 1–2. *pp*. 92–98, 1929.

The observations were made with a special tube in which electrons from an incandescent spiral were accelerated by a field into the interior of a cylindrical anode inside which there was no field. The light from the excited helium passed out through a slit in the side of the cylinder. A table gives the ratios of the intensities for two different pressures, low and high, in the case of a number of lines which are arranged in their series. In each series the ratio increases with the wave-length, so that with diminished pressure the higher lines of each series become relatively stronger. The factor (ratio) is two or three times as large for equal values of $m$ in the $2'P - m'S$ series as in the $2'P - m'D$ series (singulets), there is a similar relation for the triplets; other relations between the series are pointed out, the general result being that at low pressures the S levels become more important, and the P levels much more important, relatively to the D levels. At 0·045 mm. pressure the triplets are on the average 4·5 times stronger relatively to the corresponding singulets as they are at 6·9 mm. Curves are given showing the triplet-singulet relations, and the intensities of the lines as functions of the voltage which accelerates the exciting electrons. These curves are discussed theoretically.
H. N. A.

**2185. Spectrum of $H_2$: Bands Analogous to the Ortho-Helium Line Spectrum. O. W. Richardson and K. Das.** *Roy. Soc., Proc.* 122. *pp*. 688–718, *Feb*. 4, 1929.

An important extension of previous work by Richardson [see Abstracts 2361 (1926), 1024 (1927) and 344 (1928)] on the P, Q and R branches of the secondary spectrum. New observational data by Gale, Monk and Lee [see Abstract 1604 (1928)] enable a number of outstanding difficulties to be cleared up, and the combinations show excellent numerical agreement. The paper contains a large number of tables, with detailed discussions. It cannot be very adequately abstracted, and should be consulted in the original. New estimates are obtained for the band constants, moments of inertia and nuclear distances of the excited hydrogen molecule in different states.
H. R. R.

**2186. Influence of a Hydrogen Atmosphere upon the Arc Spectra of Some Metals. H. Crew.** *Phil. Mag*. 7. *pp*. 312–316, *Feb*., 1929.

Arc spectra of Magnesium, Zinc, Aluminium, Cadmium and Carbon were studied with a specially designed arc in a chamber filled with hydrogen, and certain phenomena which do not appear to be explicable as " pole-effects " are described. W. H. Ge.

**2187. Ultra-Violet Spectrum of Magnesium Hydride. R. W. B. Pearse.** *Roy. Soc., Proc.* 122. *pp.* 442–455, *Feb.* 4, 1929.

The paper deals with observations on the band at λ2430, and the author sought to obtain further information on the energy states of the MgH molecule which might be given by examination of the features of the hydride band spectra. Photographs of the β-system were made with a quartz spectograph of the Littrow type. In the ultra-violet spectrum α, β and γ systems are given. The system gives a strong band at λ2430, and when analysed a P, a Q and an R branch are found, each composed of lines apparently simple, but probably doublets resolved only in the region of the band spectrum. Rotation analysis shows that the final state for the λ2430 band is identical with the final $^2S$ state for the O,O band λ5211 of the α-system, and the initial state is the same as for the α-system, $^2P$. The β-system corresponds to the second member of the $^2P \rightarrow {}^2S$ series of Na, λ3302·34, 2·94. The Q-heads of other bands of the β-system were measured under low dispersion and values of the initial and final vibrational quantum numbers $n'$, $n''$ assigned. The analysis indicates that the final states of the β- and α-systems are the same. R. S. R.

**2188. Helium Spectrum in Combined Electric and Magnetic Fields. J. S. Foster.** *Roy. Soc., Proc.* 122. *pp.* 599–603, *Feb.* 4, 1929.

The parhelium line 2P − 5F, near the diffuse line λ4388, has the advantage that its mere presence is evidence of an external electric field. The perpendicular Stark component of the line which is identified by $m = \pm 2$ in the initial state increases rapidly in intensity with increasing field until in moderate fields it is a very strong line clearly separated from its neighbours, with a negligible first-order Stark effect. The author, therefore, splits this line with a superimposed and parallel magnetic field of 2700 gauss. The electric field was 96,000 volts/cm. The effects in parhelium and orthohelium are clearly additive in the sharp and principal series, and for the components of the diffuse lines which are resolved. The magnetic separation is independent of the magnitude of the Stark effect. Certain Stark components which were known to vanish in moderate fields now reappear under the action of stronger fields, as predicted in the quantum-mechanical explanation of the Stark effect in helium.

E. E. F. d'A.

**2189. Patterns and Paschen-Back Analogue in the Stark Effect for Neon. J. S. Foster and W. Rowles.** *Roy. Soc., Proc.* 123. *pp.* 80–103, *March* 6, 1929.

An experimental investigation of the Stark effect in neon is described and the displacements for patterns of 150 lines are tabulated (field strength = 70,600 volts/cm.). The observed patterns of the sharp, diffuse and combination lines are never more complicated, and in most cases are identical with those recently reported for parhelium [see Abstract 1759 (1927)]. A Paschen-Back analogue is observed in (1) the fusion of each complex line into a single asymmetric Stark effect, together with (2) the group symmetry presented by the assembly of Stark effects contributed by each group of normal and combination lines W. S. S.

**2190. Stark Effect in a Violet Region of the Secondary Spectrum of Hydrogen. J. K. L. MacDonald.** *Roy. Soc., Proc.* 123. *pp.* 103–107, *March* 6, 1929.

The Stark effect was observed for 20 lines in the region 3980–4080, the displacements of the components being tabulated (field strength = 95,000 volts/cm.). The lines fall into two groups: the lines in the short wave-length half of the range investigated being shifted towards the violet; those in the long wave-length half, towards the red. W. S. S.

**2191. Active Nitrogen. Part V (Amended). Decay of the Nitrogen Afterglow. E. J. B. Willey.** *Chem. Soc., J. pp.* 228–231, *Feb.*, 1929.

Owing to an arithmetical error in the earlier paper [see Abstract 2707 (1928)] the conclusion that the decay process of the nitrogen afterglow is of the fifth order is incorrect. This decay is probably of the third order, but is complicated by a surface action occurring at the same time as that in the bulk of the gas. The conclusions regarding the probable formation of the chemically active nitrogen during the degradation of energy from a high-level molecule initially formed from atoms through the medium of a ternary collision $2N + N_2 \rightarrow 2N_2$ remain unaffected, as do other considerations as to the behaviour of active nitrogen. T. H. P.

**2192. Arc Spectrum of Nitrogen in the Extreme Ultra-Violet. K. T. Compton and J. C. Boyce.** *Phys. Rev.* 33. *pp.* 145–153, *Feb.*, 1929.

Excitation of nitrogen by controlled electron impact was found to bring out many lines in the arc spectrum of nitrogen. These were observed with a vacuum spectrograph in the region from 500 to 1200 Å. The lines thus found, together with material of Hopfield, Bowen and Fowler in the extreme ultra-violet, and of Merton and Pilley in the visible, and the multiplets already found by Kiess, have led to a fairly complete analysis of the spectrum, in good agreement with the predictions of the Hund theory. The ionisation potential is 14·48 volts, and the metastable levels $^2D$ and $^2P$ have energies corresponding to 2·37 and 3·56 volts respectively, in good agreement with the predictions of Kaplan and Cario from a study of active nitrogen. AUTHORS.

**2193. Excitation of the Aurora Green Line in Active Nitrogen. J. Kaplan.** *Phys. Rev.* 33. *pp.* 154–156, *Feb.*, 1929.

The aurora green line has been excited in the nitrogen afterglow when oxygen was present in the discharge in which the active nitrogen was produced and observed. The interpretation of this phenomenon is based on the recent hypothesis as to the nature of active nitrogen as presented by Kaplan and Cario. AUTHOR.

**2194. Infra-Red Radiations of Active Nitrogen. P. K. Kichlu and D. P. Acharya.** *Roy. Soc., Proc.* 123. *pp.* 168–171, *March* 6, 1929.

The spectrum of active nitrogen from λ7500 to λ8900 Å. has been investigated photographically, using a constant deviation spectrograph and neocyanin plates. It is found to consist of an extension of the first positive group of nitrogen, while the important group of lines of atomic nitrogen at about λ8200 has been shown to be absent. The resonance lines at about λ1700 are now being sought. F. S.

V.
19

**2195. Spectrographic Proof of Beryllium. H. Fesefeldt.** *Zeits. f. phys. Chem.* 140. *Abt. A.* 3–4. *pp.* 254–262, *Feb.*, 1929.

The spectrum of an element contains fewer and fewer lines as the concentration decreases, and, finally, the ultimate lines are obtained. In natural minerals where a small quantity of an element is associated with silicates and oxides of other metals, the spectroscopic determination of the element is rendered difficult. The spectrographic proof of the presence of beryllium in mixtures of $BeO\text{-}Al_2O_3$ was studied, a Hilger large quartz spectrograph being used. The mixtures were placed in the lower carbon of the arc, a cup being hollowed out to contain the mixture under examination. The most delicate Beryllium lines were found to be 2348·62, 3130·42, 3131·06. The presence of the alkali metals reduced the delicacy of the method. F. J. B.

**2196. Quantum Analysis of the Beryllium Oxide Bands. Jenny E. Rosenthal and F. A. Jenkins.** *Phys. Rev.* 33. *pp.* 163–168, *Feb.*, 1929.

New measurements of the structure lines in the (0, 0), (1, 1), (0, 1), (1, 2), (1, 0) and (2, 1) bands of the visible BeO system are reported. Each band has P and R branches of almost equal intensity, the lines of which are strictly single. There is probably but one missing line at the origin. This structure characterises the system as $^1S \rightarrow {}^1S$, the odd multiplicity agreeing with the even number of electrons in neutral BeO. The rotational terms are investigated by the combination principle, and can be represented by $F(j) = Bj(j+1) + D[j(j+1)]^2 + \ldots$ with $j$ integral as required for $^1S$ states. One perturbation is found, consisting of a displacement of the line R(49) in the (1, 0) band by 0·45 cm.$^{-1}$ toward lower frequencies, with no sign of doubling. The following equation is obtained for the null-lines: $v_0 = 21{,}254\cdot05 + 1370\cdot81(n'+\frac{1}{2}) - 7\cdot76(n'+\frac{1}{2})^2 - 1487\cdot45(n''+\frac{1}{2}) + 11\cdot87(n''+\frac{1}{2})^2$.

The principal molecular constants, evaluated from rotational term-differences using the new quantum mechanics energy formula, are: $B_0' = 1\cdot5771$, $B_0'' = 1\cdot6514$, $\alpha' = -0\cdot0160$, $\alpha'' = -0\cdot0186$, $D_0' = -8\cdot44 \times 10^{-6}$, $D_0'' = -8\cdot26 \times 10^{-6}$, $\beta' = +0\cdot03 \times 10^{-6}$, $\beta'' = -0\cdot06 \times 10^{-6}$, $F_0' = 22 \times 10^{-12}$, $F_0'' = 12 \times 10^{-12}$, the zero subscripts referring to the vibrationless condition. The nuclear separation in the final state is: $r_0'' = 1\cdot327 \times 10^{-8}$ cm. AUTHORS.

**2197. Energies of Dissociation of Cadmium and Zinc Molecules from an Interpretation of their Band Spectra. J. G. Winans.** *Phil. Mag.* 7. *pp.* 555–565, *March*, 1929.

The atomic cadmium resonance line at 2288 appears, as a narrow absorption line, when white light is passed through a heated absorption cell containing Cd vapour at low pressure. It broadens into a band reaching from 2207 to 2800 when the pressure is raised. Absorption bands at 2212 and 2114 were observed. The electrodeless discharge shows a continuous spectrum, with maxima at 2288, 2980, 3000 and 4400. The band at 2114 appears, but that at 2212 is absent. A form is suggested for the potential energy curves for the cadmium molecule, which explains the band from 2207 to 2800, this is attributed to absorption by two colliding atoms, forming a stable excited molecule; the curves also explain the appearance of the 2212 band in absorption, but not in emission, and the continuous structure of the electrodeless discharge between 2220 and 3000. The value 0·200 volt is obtained for the energy of dissociation of $Cd_2$. A similar explanation of the zinc spectra gives 0·246 for the energy of dissociation. The energies of dissociation of Zn, Cd and Hg molecules are proportional to the atomic heats of fusion. The 2114 band of Cd, and the 2002 band of Zn, can be represented by an absorption to a stable molecular state whose vibrational levels converge to $2^1S$ or $3^1D$. H. N. A.

**2198. Transformation Spectrum of the Ruby. E. L. Nichols and H. L. Howes.** *Nat. Acad. Sci., Proc.* 15. *pp.* 139–146, *Feb.*, 1929.

A small slab of synthetic ruby mounted on the tip of a vertical splinter of alundum was heated directly by a hydrogen flame mixed with sufficient oxygen to raise the temperature to about 1000° C. The spectrum was then continuous, with regions of unusual intensity in the green and blue. When the ruby was allowed to cool, a set of narrow bands appeared at about 775° C. and disappeared about 600° C. This temperature interval is connected with profound changes in the absorption of light by the ruby. The transformation bands occur in sets having a constant frequency interval of 36·7. All the known absorption and fluorescence bands are members of these sets. A. C. M.

**2199. Measurement of Intensity Relation between Two Emission Lines of the Sodium Atom with the same Initial State (1S–3P) and (2S–3P). C. Weiss.** *Ann. d. Physik*, 1. 5. *pp.* 565–612, *March* 12, 1929.

The object of the research was to study the relation between the probabilities of transfers between different states. Three lines starting from the 3P state were experimented with, but 3D − 3P, $\lambda = 90{,}850$ Å., could not be produced with sufficient intensity to permit of measurements with the very sensitive microradiometer employed; 2S − 3P, $\lambda = 22{,}070$ Å. could be measured with this, and compared with a visible line 2P − 4D, $\lambda = 5686$ Å., which in turn could be compared photographically with 1S − 3P, $\lambda = 3302{\cdot}6$ Å., which lies in the ultra-violet and cannot be measured with the microradiometer. In this way the relation between the intensities of 1S − 3P and 2S − 3P can be indirectly measured. Details are given of the very delicate measurements required in the investigation and the method finally adopted to obtain a light source which was sufficiently uniform, and gave the lines with satisfactory intensity. Passages from the 3P to the 2S state are very much more frequent than those to the 1S state, the ratio between the probabilities was found to be 25 : 1; this is larger than the ratio 4 : 1 calculated by Bartels, who used the Fuess central force model, and the correspondence principle. H. N. A.

**2200. Fine Structure in the K-Level Variation. V. Dolejšek and K. Pestrecov.** *Zeits. f. Physik*, 53. 7–8. *pp.* 566–573, 1929.

New measurements of the K-absorption edge for the elements of atomic numbers 26, 28, 29 and 30 are reported. The frequency values for the K edges of the elements of atomic numbers 12 to 90 are shown to deviate from the formula $\frac{\nu}{R} = a + bN + cN^2 + dN^3 + eN^4$ (constants chosen to fit rare gas values) by an amount which tends to vary continuously and periodically in passing from low to high atomic numbers.

When only those measurements made on the *free* element are taken into account this effect is shown quite definitely. W. S. S.

**2201. Action of X-Rays on Ferrous Sulphate Solutions. H. Fricke and S. Morse.** *Phil. Mag.* 7. *pp.* 129–141, *Jan.*, 1929.

X-rays have an action on aqueous solutions of ferrous sulphate which causes the ion to pass from the ferrous to the ferric state. The authors describe an investigation of this reaction which was made in the course of a study of the quantitative relationship between chemical effects and the ionisation of a gas in its dependence on the wave-length of the Röntgen rays. The results of this study are to be reported later. From the results of the observations on ferrous sulphate described in the present paper it seems probable that the transformation of the ferrous ions is a secondary effect due to activated water molecules, which in turn are produced by the secondary X-ray electrons. Apparently X-rays are able to reduce the ferric ion, but the transition to the stationary part of the reaction is unexpectedly abrupt. J. J. S.

**2202. Röntgen Photolysis of Hydrogen Peroxide. O. Risse.** *Zeits. f. phys. Chem.* 140. *Abt. A.* 1–2. *pp.* 133–157, *Jan.*, 1929.

Reference is made to the work of Glocker and Risse [see Abstract 2730 (1928)] on the ray energy needed for decomposing $H_2O_2$ and $K_2S_2O_8$ molecules in 1/600 mol. solutions. For very dilute solutions it is found that the rate of reaction is independent of the concentration, while for higher concentrations up to 1/20 mol. the monomolecular equation is more or less applicable. The influence of intensive Röntgen rays on the changes of pure water of specific conductivity $1 \cdot 5$ to $2 \cdot 28 \; 10^{-6}$ mhos and $p$H $6 \cdot 0$ to $7 \cdot 0$ upon investigation by the author shows that the quantity of $H_2O_2$ formed corresponds to the amount of oxygen remaining after the water has been boiled in order to remove the air gases dissolved, also a lasting displacement of the actual acidity by one-half to one-tenth power, and an increase in the specific conductivity to about double. Development of gases in the exposed water is not observed. The formation of atomic oxygen or hydrogen by Röntgen-ray decomposition has so far not been shown. J. K.

**2203. Diffraction of X-Rays by Ruled Gratings, Spectrographical Junction between X-Rays and Ultra-Violet Rays. J. Thibaud.** *Ann. Soc. Sci. de Bruxelles*, 48. *pp.* 145–168, *Dec.*, 1928.

Gives an account of the author's work on the subject, which commenced in 1925. [See also Abstract 193 (1929).] H. N. A.

**2204. Connection between the Limiting Frequencies of the Characteristic Röntgen Radiations. S. Björck.** *Zeits. f. Physik*, 53. 3–4. *pp.* 228–233, 1929.

Shows that for the elements between manganese and iodine simple relations connect the limiting frequencies for the various levels of the Röntgen radiations. Their validity is clearly demonstrated in three tables of frequencies given, in which comparisons are made between the observed and calculated values. The calculated values generally are higher than the values obtained from the absorption edges. This is to be expected, experimental results showing that the frequency corresponding to the principal absorption limit is lower than the true limiting frequency. R. C. F.

**2205. Scattering of Röntgen Radiation from Graphite. W. Ehrenberg.** *Zeits. f. Physik*, 53. 3–4. *pp.* 234–236, 1929.

The author attempts to reproduce the effect, observed by Davis and Mitchell [see Abstract 516 (1929)], in which three lines displaced on the long wave-length side of $MoK\alpha_1$ were obtained. Using a Seemann spectrograph and exposures up to 120 hours, no indication of these displaced lines could be observed. From a discussion of the possibilities of occurrence of these lines, it is shown that the line displaced by 0·0113 Å. from $MoK\alpha_1$ is probably due to uranium present as an impurity in the graphite. No similar explanation can be offered for the other two displaced lines. R. C. F.

**2206. Scattering of X-Rays by Single Molecules. P. Debye, L. Bewilogua and F. Ehrhardt.** *Phys. Zeits.* 30. *pp.* 84–87, *Feb.* 1, 1929.

Previous investigations on scattering of X-rays by liquids had given bands capable of being explained as due to interference by molecules as wholes. A theory is difficult to frame, and the attempt was made to eliminate the effect of molecules by using gases or vapours. In these we have practically only intramolecular interference. Experiments on these lines show the interference effects sought for. Mathematical argument and experimental work, with photographs. A. D.

**2207. Absorption of X-Rays from 0·63 to 2 Å.U. I. Backhurst.** *Phil. Mag.* 7. *pp.* 353–373, *Feb.*, 1929.

A description of the results of a series of experiments on the absorption of fairly long X-rays (0·63–2·0 Å.) in silver, aluminium, platinum, gold and copper. The principal difficulty hitherto met with experimentally has been the inconstancy of the source of X-rays, and a special tube is described which can be kept constant to about 1 %. The radiations used were obtained by reflection from a calcite crystal, a balance method using a duplicate arrangement being also employed to check results obtained with a single ionisation chamber direct method. For aluminium it is found that $\mu/\rho = 14{\cdot}3\lambda^{2{\cdot}91}$, for silver $\mu/\rho = 69{\cdot}9\lambda^{2{\cdot}79}$. Definite departures from the $\lambda^3$ law are found and considered to be outside the limits of experimental error, the value of the index being somewhat less than three in this region. For platinum and gold the region of wave-length around the L-absorption edges was investigated closely with the object of measuring the magnitude of the L "jumps" as accurately as possible. It was found by E. Jonsson that the total L-absorption jump is equal to the ratio of the energy levels $L_1$ and $M_1$, and the results agree to about 1 %. The same rule does not apply for the partial L jumps, but certain equalities are noted. Agreement is found with theoretical predictions on the basis of Stoner's scheme of electron distribution. For copper $\log \mu/\rho = 2{\cdot}116 + 2{\cdot}72 \log \lambda$ and $1{\cdot}173 + 2{\cdot}95 \log \lambda$ on opposite sides of the K jump. The slope of the K-absorption curve near the K edge is considerably less on a $\log \mu/\rho - \log \lambda$ graph than the slope of the L curve near the K edge. No general law has been found that would fit accurately the data obtained for all the elements observed, but that recently found by Jönsson with respect to electronic absorption would appear to be very nearly so. W. V. M.

**2208. Reflection of Soft X-Rays. S. D. Gehman.** *Phys. Rev.* 33. *pp.* 141–144, *Feb.*, 1929.

Reflecting power of Al, C and Pt for non-characteristic soft X-rays (40–

500 volts) as function of angle and voltage. Non-characteristic soft X-rays of voltage range 40 to 500 were passed through a slit system and then reflected from the polished surfaces of various mirrors in a high vacuum. The reflecting power of the mirror was measured by a photoelectric method, as a function of the voltage for a given angle of incidence and as a function of the angle for a given voltage. The reflecting power:: voltage curve for aluminium, angle of beam and mirror 13°, shows a broad maximum between 68 and 140 volts, and falls off rapidly as the voltage increases. The same curve for carbon, angle 14°, has a similar maximum between 250 and 350 volts. For a platinum mirror, same angle, the curve rises for voltages up to about 100 and then the reflecting power decreases very slowly for higher voltages. The reflecting-power :: angle-of-incidence curve shows a rapid decrease of the reflecting power as the angle of incidence decreases; its form appears to be practically independent of the voltage for the range used. The results appear to justify the conclusion that for aluminium and carbon, light elements, the reflecting-power:: plate-voltage curve shows a maximum, related to a critical potential, but the resolving power of the method, as here used, is inadequate to locate these potentials with useful precision. AUTHOR.

## RADIOACTIVITY.

**2209. Application of Valve Amplifiers for Counting Corpuscular Rays. G. Ortner and G. Stetter.** *Akad. Wiss. Wien, Ber.* 137. 2*a*. *Nos.* 9–10. *pp.* 667–703, 1928.

The paper deals with the design of an amplifier for use in magnifying the primary ionisation produced by individual corpuscular rays (in particular H-rays). The grid of the first valve is connected to the electrode in the ionisation chamber, and on entrance of a ray the grid potential first rises linearly to a value determined by the number of ions produced, then falls off exponentially. A theoretical discussion is given of the corresponding variations in the grid potentials of the second and third values, the coupling being by means of transformers (perfect coupling assumed). It appears that the potential disturbance is completely changed in form, but the following general results hold good: (1) the maximum potential reached at the second or third valve is proportional to the amount of initial ionisation; (2) for very rapid charging of the first grid (small charging time) the maximum potential reached and the integral of the rectified potential are practically independent of the charging time. The transformer amplifier necessitates final rectification, and this involves an undesirable " threshold " effect. Resistance capacity amplifiers designed to give distortionless amplification were investigated, but found to be too unstable at the high amplification required. By the use of a special four electrode valve, however, a resistance-coupled arrangement was obtained which gave the desired distortionless amplification of the initial potential disturbance, with measurement of the end effect by means of a string galvanometer in the final anode circuit. Experimental investigations of various aspects of the problem are described, including the use of the amplifiers in atomic disintegration experiments. W. S. S.

**2210. Yield in Artificial Atomic Disintegration. W. Bothe and H. Fränz.** *Zeits. f. Physik*, 53. 5–6. *pp.* 313–316, 1929.

A reply to recent criticisms by Kirsch and Pettersson of the authors' work on the subject. Cases are mentioned in which the yield deduced from some of the Vienna experiments has recently been reduced on reconsideration of the details, thus bringing the results nearer to those obtained by the authors. They explain that their counter was calibrated by means of non-homogeneous H-rays, since sufficiently strong homogeneous rays were not available, and make it clear that since the counter actually responded to $\beta$-rays it would certainly respond to H-rays. K and P suggest that the calibration values were too large on account of the lack of homogeneity in the H-rays employed, but give no figures in support of this. The authors can see no possibility of bringing the two sets of results into accordance, but hope shortly to be able to report on new experiments. H. N. A.

**2211. Quantum Theory of Radioactive Disintegration. G. Gamow.** *Zeits. f. Physik*, 53. 7–8. *pp.* 601–604, 1929.

A reply to Laue's criticism of the author's theory [see Abstract 1585 (1929)]. W. S. S.

**2212. Quantum Mechanics and Radioactive Disintegration. R. W. Gurney and E. U. Condon.** *Phys. Rev.* 33. *pp.* 127–140, *Feb.*, 1929.

Application of quantum mechanics to a simple model of the nucleus gives the phenomenon of radioactive disintegration. The statistical nature of the quantum mechanics gives directly disintegration as a chance phenomenon without any special hypothesis. Section 1 contains a presentation of those features of quantum mechanics which are here used, and gives a simple calculation of the disintegration constant. Section 2 discusses the qualitative application of the model to the nucleus. Section 3 presents quantitative calculations amounting to a theoretical interpretation of the Geiger-Nuttall relation between the rate of disintegration and the energy of the emitted $\alpha$-particle. In getting this relation one arrives at the rather remarkable conclusion that the law of force between the emitted $\alpha$-particle and the rest of the nucleus is substantially the same in all the atoms even where the decay rates stand in the ratio 1022. Section 4 calls attention to the natural way in which the paradoxical results of Rutherford and Chadwick on the scattering of fast $\alpha$-particles by uranium receive explanation with the model here used. Section 5 discusses certain limitations inherent in the methods employed. AUTHORS.

**2213. Adsorption of Radium Emanations. A. Becker and K. H. Stehberger.** *Ann. d. Physik*, 1. 4. *pp.* 529–555, *Feb.* 25, 1929.

The adsorption by carbon and silica gel is quantitatively followed by means of a static method. Adsorption by solids, like that by liquids, presents stationary conditions of equilibrium, which are determined by a concentration relation, dependent upon the temperature, between the emanation, the solid or liquid substance and the surroundings. The laws of adsorption for ordinary gases are confirmed, but at partial pressures are so small as have never been investigated. The equilibrium of the emanation is independent of the nature and the pressure of the accompanying gas, of the quantity of the adsorbing substance, of the volume or of the partial pressure of the emanation, and depends only on the adsorbing substance and on the temperature. The adsorption coefficient corresponding to the equilibrium condition is determined from − 80° C. to + 100° C.; the reaction isochore is traced out. Carbon has a high adsorption coefficient and marked temperature changes. Silica gel has only at the temperature of solid $CO_2$ an adsorption equal to that of carbon at room-temperature. It remains to be investigated how far this difference depends on the nature of the substance, and how far on the effective area. The dynamical experiment of passing gas through adsorbent layers is criticised. It is found that the determination of the adsorption coefficient by this means would require modifications of the experiment which would be very difficult to apply. A. D.

**2214. Transmutation of Elements. L. Thomassen.** *Phys. Rev.* 33. *pp.* 229–238, *Feb.*, 1929.

Test for the transmutation in the tungsten target of an X-ray tube: X-ray spectrograms of the tungsten target of a deep-therapy X-ray tube were taken before and after operating it for about 80 hours at 2–3 mA and 207 kV peak voltage. No lines other than those due to tungsten were found before or after. Test for transmutation of lead in a lead arc: The experiments of Smits and Karssen [see Abstract 1206 (1927)] with the lead arc were duplicated as nearly as possible. Under no conditions of current density was there any spectroscopic evidence of a transmutation of the lead to mercury. Test for transmutation of lead in a high potential discharge between lead electrodes in $CS_2$: The experiments of Smits and Karssen were carefully repeated. Some evidence of Hg in the residue from the electrodes was found. The indications are, however, that the mercury comes from the electrodes, the carbon bisulphide or dust particles, rather than from a transmutation of lead. AUTHOR.

**2215. Relative Velocities of the $\alpha$-Particles Emitted by Certain Radioactive Elements. G. C. Laurence.** *Roy. Soc., Proc.* 122. *pp.* 543–551, *Feb.* 4, 1929.

Direct comparison by deflection in a magnetic field of the velocities of the $\alpha$-particles from thorium C and C′ and radium F with that of the $\alpha$-particle from radium C′. The deflections of the particles from a compound source (*e.g.*, radium and thorium active deposits) on a fine wire are recorded photographically. Owing to the different rates of decay of the products concerned, the variation of the magnetic field during an exposure has to be accurately known. Details are given of the precautions taken to minimise errors due to this cause. Taking Briggs' value for radium C′ [see Abstract 1633 (1928)] as standard (RaC′, $v = 1{\cdot}923 \times 10^9$ cm./sec.), the values obtained are: ThC, $v = 1{\cdot}709 \times 10^9$ cm./sec.; ThC′, $v = 2{\cdot}054 \times 10^9$ cm./sec.; and RaF, $v = 1{\cdot}592 \times 10^9$ cm./sec. There is a brief discussion of the discrepancies between these relative values and the corresponding ratios as computed from the respective ranges. H. R. R.

**2216. Investigation of the Ranges of the Long-Range $\alpha$-Particles from Thorium C and Radium C, using an Expansion Chamber. R. R. Nimmo and N. Feather.** *Roy. Soc., Proc.* 122. *pp.* 668–687, *Feb.* 4, 1929.

The ranges are examined in a carefully designed Wilson cloud chamber. Precautions are taken to secure definite conditions in the chamber at the instant of track formation, and to minimise errors due to tracks of fast protons. The original should be consulted for the experimental details and the discussion of the limitations of the method. For thorium C two groups are found with (extrapolated) ranges of 11·70 and 9·90 cm. respectively. In addition there are a few tracks of range greater than 12·5 cm., which are also attributed to $\alpha$-particles from the source. With radium C the conclusions are less definite. There is definitely a group with range 9·16 cm., and a number of particles with ranges between 7·5 and 12·5 cm. The measurements of these particles give strong indications, but no absolute certainty, of groups with ranges 8·1 and 11·0 cm. The position here is more complex than had previously been supposed. The paper gives an extensive bibliography of previous work on the long-range particles [see also Abstract 1588 (1929)]. H. R. R.

**2217. Spatial Distribution of the $\gamma$-Radiation of Radium in Media composed of Light Atoms. M. Bruzau.** *Ann. de Physique,* 11. *pp.* 5–140, *Jan.,* 1929.

The problem is not amenable to direct calculation on account of the very complicated effects of scattering—production of recoil electrons and gradual degradation of the primary $\gamma$-radiation—and the difficulty of laying down a sufficiently definite "effective" wave-length. The paper contains a detailed theoretical consideration of these aspects of the problem, with appropriate experimental checks, and lays down a satisfactory procedure for the exploration of a scattering medium (*e.g.,* water). The ionisation at different points is measured in a small ionisation chamber (2 cm.$^3$), which is calibrated against a much larger chamber containing air under pressure, in which the "wall effect" can be eliminated. It appears to be possible, by carefully selected methods, to get reliable estimates of the distribution in space of the $\gamma$-radiation. The total energy of the $\gamma$-rays from radium is found in these measurements to be in excellent accord with the calorimetric measurements of Ellis and Wooster. There are brief discussions of the applications of the principles developed in this paper to problems in radiotherapy and to points in connection with the penetrating radiations in the atmosphere. In particular, reasons are given for suspecting that the spectrum of the cosmic rays extends further into long-wave regions than is supposed by Millikan. [See next Abstract.] H. R. R.

**2218. Absorption of Penetrating Radiation. L. H. Gray.** *Roy. Soc., Proc.* 122. *pp.* 647–668, *Feb.* 4, 1929.

A theoretical contribution to the problem of interpreting existing measurements on the penetrating radiations in the atmosphere. If these are very short $\gamma$-radiations, the observed absorption must be almost entirely by scattering, and the measured ionisation must be mainly due to recoil electrons produced by the penetrating radiations and to the "degraded" $\gamma$-rays resulting from the scattering process. Only a small fraction can be due to recoil electrons produced by scattering of penetrating radiation in the air inside the electroscope. There is a full discussion of the effect upon the ionisation current of the material and thickness of the walls of the electroscope. Approximate calculations are given of the relative magnitudes of the ionisation produced by primary and scattered radiations at any point. The scattering formulæ of Klein and Nishina appear to give a closer fit with the experimental data than those of Compton and Dirac. There is a discussion of the relation between the apparent absorption coefficient of a homogeneous isotropic radiation and the true scattering coefficient of the primary radiation. [See preceding Abstract.] H. R. R.

# HEAT.

**2219. Thermal Conductivity of Lead and of Single-Crystal and Poly-Crystal Zinc. C. C. Bidwell and E. J. Lewis.** *Phys. Rev.* 33. *pp.* 249–251, *Feb.*, 1929.

The thermal conductivities of lead and of single-crystal and poly-crystal zinc over the temperature range − 250° C. to + 100° C. determined by a method previously described by Bidwell are reported upon. The thermal conductivity increases for these metals as the temperature is lowered, but shows no extraordinary increase at extreme low temperatures as was found for lithium. The single-crystal zinc shows about 18 % better thermal conductivity than the poly-crystal sample. A zinc sample cast in open air showed about 7 % poorer conductivity than a sample prepared *in vacuo*. The data are in agreement with the law $k/a\mathrm{C} = \mathrm{K/T} + \mathrm{K}'$.

AUTHORS.

**2220. Thermal Conductivity of Gas Mixtures. T. L. Ibbs and A. A. Hirst.** *Roy. Soc., Proc.* 123. *pp.* 134–142, *March* 6, 1929.

A graphical method for determining the thermal conductivity of a gaseous mixture from the katharometer reading is explained. The mixtures considered are helium and argon, carbon dioxide and hydrogen, hydrogen and argon, hydrogen and nitrogen.

J. S. G. T.

**2221. New Self-Registering Apparatus to Determine the Expansion of Solid Bodies. W. M. Cohn.** *Zeits. f. techn. Physik*, 10. 3. *pp.* 103–106, 1929.

The principle of the method is to find the difference between the expansion of the body tested and a sample of quartz. In the direct measurement the expansion is magnified optically and observed by scale and telescope, an accuracy of ± 0·5 % being obtained. In the self-registering apparatus the light after emerging from the telescope is reflected to a camera by a mirror galvanometer, while the temperature of the body is found by a thermoelement. The expansion of bodies can be regulated during the whole heating process. Up to 200° C. an oil bath is used for heating, and for higher values an electrical oven is employed. Small details in the expansion curve not apparent to direct observation are recognised in this way, and particularly points where changes of state occur. Examples are shown of expansion curves for zirconium oxide (20°–200° C.) and lead glass (0°–560° C.). Diagrams and photographs are given of the apparatus as used at the Reichsanstalt.

R. S. R.

**2222. Methods and Apparatus used in the Cryogenic Laboratory. High Vacuum Pump with Great Capacity. W. Gaede and W. H. Keesom.** *K. Akad. Amsterdam, Proc.* 31. 9. *pp.* 985–988, 1928. *Comm. No.* 195*a from the Phys. Lab., Leiden.*

Full description of a new form of pump with a great exhaust capacity. It is shown that for air the pump has a capacity for exhaust, *i.e.*, the volume of gas removed per second measured at the pressure of the pump, which amounts to 130 litres per second for air and to 420 for helium. With the present type of pump an exhaust capacity has been obtained fully eight times that of the original 3-stage pump. Curves of the working values and efficiency of the pump are given showing the relationship between the pressure and the displaced gas volume measured at normal pressure. The fact that these results give straight lines which by extrapolation pass through the origin proves that the pump has a constant exhaust capacity down to the smallest pressures at which it was tested.

S. G. B.

**2223. Methods and Apparatus used in the Cryogenic Laboratory. Motor-Driven Ice Cutter. W. H. Keesom.** *K. Akad. Amsterdam, Proc.* 32. 1. *pp.* 20–22, 1929. *Comm. No.* 195*b from the Phys. Lab., Leiden.*

A description of a rotary ice cutter to give pieces of ice 3 mm. in linear dimensions. About 1·7 kg. of ice are cut per minute, and the rotary arrangement is driven by a 1-h.p. motor making 20 r.p.m. per minute. Full details of construction are given. The machine is capable of dealing with ice blocks up to a size of 19 × 19 cm. S. G. B.

**2224. Specific Heat of Molybdenum from 250° C. to − 40° C. D. Cooper and G. O. Langstroth.** *Phys. Rev.* 33. *pp.* 243–248, *Feb.*, 1929.

By the use of a long covered tube in the calorimeter proper of an ordinary Richards adiabatic calorimeter, values for the heat capacities of metals from high temperatures may be obtained, even when the falling body is not protected from radiation losses by a metal jacket. The experimental procedure for such a determination is given. A calorimeter arrangement in which the metal was first partially cooled in the calorimeter and then allowed to come in contact with the water of the calorimeter proved unsuitable as is shown. The specific heats of molybdenum between the temperatures of − 30° C. and 300° C. are given by the following equation with an accuracy of about 1 %:

$$C_p = 0\cdot0593 + 0\cdot000013(T + 40) - 0\cdot0265/(T + 40)^{1\cdot06}.$$

Stern's equation, which is linear, agrees with the values given between 50° C. and 300° C. Below 50° C. the curve shows a decided bend.

AUTHORS.

**2225. Heats of Dilution and Specific Heats of Barium and Calcium Chloride Solutions. T. W. Richards and M. Dole.** *Am. Chem. Soc., J.* 50. *pp.* 794–802, *March*, 1929.

On the Debye and Hückel theory of complete dissociation the deviations of solutions of compounds with unsymmetrical valences from those predicted by the perfect gas laws are due partly to the different electrical charges on the ions. In this investigation the specific heats of a concentrated solution of calcium and barium chloride have been measured directly, whilst the specific heats and heat capacities of all the solutions have been determined by the indirect method. The heats of dilution and the loss in heat capacity on dilution have been calculated from the observations. Qualitative agreement with the Debye and Hückel theory has been found in dilute solutions; both calcium and barium chloride have positive heats of dilution at very small concentrations as predicted by the theory. H. H. Ho.

**2226. Specific Heats of Sodium and Potassium Hydroxide Solutions. T. W. Richards and L. P. Hall.** *Am. Chem. Soc., J.* 51. *pp.* 707–712, *March*, 1929.

Since this datum forms the basis for the specific heats of other solutions, heats of dilution, etc., it has been re-evaluated, and several modifications and improvements are described in the differential method for the determination of specific heats [see Abstract 2312 (1925)]. The following values were found for specific heats at 18·0°; NaOH . $25H_2O$, 0·9127, thus confirming the recent high value found by Richards and Gucker; NaOH . $50H_2O$, 0·946; NaOH . $100H_2O$, 0·9690; and KOH . $100H_2O$, 0·9569. H. H. Ho.

**2227. Heats of Dilution and Heat Capacities of Hydrochloric Acid Solutions. T. W. Richards, B. J. Mair and L. P. Hall.** *Am. Chem. Soc., J.* 51. *pp.* 727–730, *March*, 1929.

Specific heats of solutions of hydrochloric acid with 25, 50 and 100 moles of water per mole of acid have been measured directly by the twin calorimeter method at 18°, and heats of dilution over the range HCl . $25H_2O$ to HCl . $800H_2O$ at 16° and 20°. The specific heats of the dilute solutions were calculated by the use of the Person-Kirchhoff relation. H. H. Ho.

**2228. Thermochemical Behaviour of Weak Electrolytes. T. W. Richards and B. J. Mair.** *Am. Chem. Soc., J.* 51. *pp.* 740–748, *March*, 1929.

Previous work on strong electrolytes [see preceding Abstract] is now extended to weak ones. The heats of dilution of citric acid, the acid citrates and sodium citrate have been measured at 16° and 20° over the concentration range of 50 moles to 1600 moles of water per mole of substance. The heat capacities over the same range have been calculated with the aid of the Person-Kirchhoff equation. No relationship has been found to exist between the degree of ionisation and heat of dilution, hence some factor or factors other than ionisation play a predominant part in the heat of dilution of these solutions. The regularity in the decrease of the heat capacity of these solutions has been explained as due to the number of ions formed. The heat of neutralisation of citric acid and the acid citrates has been measured, but the values found are much less than for strong acids. The temperature coefficient of the heat of neutralisation of these acids is decidedly smaller than for inorganic acids, and in one case $Na_2HC_6H_5O_7 . 100H_2O + NaOH . 100H_2O$ is of opposite sign. The various results are fully discussed. H. H. Ho.

**2229. Thermochemical Behaviour of Sodium Hydroxide Solutions. T. W. Richards and L. P. Hall.** *Am. Chem. Soc., J.* 51. *pp.* 731–736, *March*, 1929.

The heat of dilution of NaOH . $10H_2O$ has been measured at 16° and 20°, the change from heat evolved to heat absorbed at 20° being at NaOH . $17·5H_2O$. The specific heats of more concentrated solutions were calculated by the Person-Kirchhoff law to be 0·868 at 18° for a solution of NaOH . $10H_2O$ and 0·896 at 18° for NaOH . $17·87 H_2O$. Further data are included to confirm the short extrapolation necessary to correct the heat of dilution of NaOH . $25·31H_2O$ and NaOH . $50·38H_2O$ to integral values [see Abstract 1911 (1929)]. Earlier results with sodium hydroxide solutions on heats of dilution, specific heats and heats of neutralisation have been recalculated and compared with recent researches. The heat of neutralisation at 20° of hydrochloric acid and sodium hydroxide is calculated to be 13·65 cal. at infinite dilution. H. H. Ho.

**2230. Heat of Neutralisation of Acetic Acid. T. W. Richards and B. J. Mair.** *Am. Chem. Soc., J.* 51. *pp.* 737–740, *March*, 1929.

The importance of this value and its significance in calculating the heat of formation of water from its ions has been emphasised in a recent paper by Richards and Gucker [see Abstract 1911 (1929)]. At concentrations of $C_2H_4O_2 . 100H_2O$ and $NaOH . 100H_2O$ the heat of neutralisation was found to be 54·324 joules at 20°. At other concentrations the heat of neutralisation is calculated with the aid of thermochemical data presented in previous publications [see preceding Abstract]. By extrapolation, upward for acetic acid and downward for strong acids, the heat of reaction, $H^+ + OH^- = H_2O$, was found to be 57·07 kj., or 13·65 cal. at 20°. H. H. Ho.

### 2231. Heat Capacities of Organic Compounds at Low Temperatures. Part II. Low-Temperature Thermostat. Reference Tables for Thousandth Degree Copper-Constantan Thermocouple from 85° to 310° K. J. C. Southard and D. H. Andrews. *Frank. Inst., J.* 207. pp. 323–339, *March*, 1929.

In the course of the work on the heat capacities of organic compounds at low temperatures two requisites were found essential: (1) An absolute accuracy of 0·01° C. and a relative accuracy of at least 0·002° C. in temperature measurements. (2) This temperature scale should be based on the International temperature scale. To accomplish these factors it was essential that a thermostat capable of maintaining a temperature constant to within 0·001° should be constructed. A full description is given of the construction and working of such a low-temperature thermostat. The thermostat bath is of pentane contained in a cylindrical copper vessel with walls 2 mm. thick. A heating unit (resistance of 40 ohms) is wound round the outside of the vessel, and the whole is placed inside a small pyrex Dewar flask. This apparatus is entirely placed in a bath of liquid air contained in a larger Dewar flask. The experimental details are given, and the results of the calibration of the thermocouple are incorporated in a full set of tables. It is also shown that the temperature gradient per unit length between the hot and the cold junctions of the thermocouples does not affect the e.m.f. noticeably, provided the wire is homogeneous. S. G. B.

### 2232. Specific Heats and Vapour Pressures of Systems which Consist of Water and the Oxides of Zirconium, Thorium and Tin. G. F. Hüttig, S. Magierkiewicz and J. Fichmann. *Zeits. f. phys. Chem.* 141. *Abt. A.* 1–2. *pp.* 1–34, *March*, 1929.

At the outset preparative details are given for the various substances investigated, following which come the specific heat measurements. A limiting law is then sought for the dependence of the specific heats of metallic oxide hydrates on their water content. The experimental vapour pressure data are then given, followed by a theoretical discussion of the thermodynamics and thermochemistry of the system $SnO_2|H_2O$. A criticism is also included of experimental methods for the determination of the state diagrams. The latter are then discussed for the systems $ZrO_2|H_2O$, $ThO_2|H_2O$ and $La_2O_3|H_2O$. The ageing of systems is next considered, and, finally, a comparison is made of the state diagrams of the oxide-hydrates of the different metals. H. H. Ho.

### 2233. Heat Capacities of Ethyl and Hexyl Alcohols from 16° K. to 298° K. and the Corresponding Entropies and Free Energies. K. K. Kelley. *Am. Chem. Soc., J.* 51. *pp.* 779–786, *March*, 1929.

The paper gives thermal data for ethyl and hexyl alcohols similar to those given in an earlier paper [see Abstract 1601 (1929)] for methyl alcohol. The measurements extend to liquid hydrogen temperatures in small temperature intervals. Specific heats of ethyl alcohol crystals, glass and liquid; and of hexyl alcohol crystals and liquid from 16° to 298° K. are given in tables and in a graph. Temperatures and heats of fusion are found to be: for ethyl alcohol, 158·5° K, and 1200 cal./mole; for hexyl alcohol, 225·8° K, and 3676 cal./mole. Entropies, $S_{298 \cdot 1}$ for one mole of liquid, are: for $C_2H_5OH$, $38 \cdot 4 \pm 0 \cdot 3$ E.U.; for $C_6H_{13}OH$, $68 \cdot 6 \pm 0 \cdot 4$ E.U. The free energies of formation of the compounds at 298·1° K. are calculated from the fundamental equation $\Delta F = \Delta H - T\Delta S$, and are found to be: ethyl alcohol, — 43,300; hexyl alcohol, — 41,700. Certain regularities in the thermal data for the normal aliphatic alcohols are discussed. T. B.

**2234. Vapour Pressure and Vapour Density of Intensively Dried Ammonium Chloride. W. H. Rodebush and J. C. Michalek.** *Am. Chem. Soc., J.* 51. *pp.* 748–759, *March*, 1929.

A review of previous work is first given, following which comes a detailed description of an experimental investigation of intensively dried ammonium chloride. It is concluded that the vapour pressure of ammonium chloride is unaffected by such intensive drying, since after 10 days at 60° in a high vacuum ammonium chloride appears to be completely dissociated in the vapour state. It is not possible to assert positively that the salt was dried sufficiently to produce the results reported by Baker and co-workers, but the remarkable lag in evaporation and condensation observed in every case where the salt was dried might account for the high results obtained by Baker in his use of the Victor Meyer and Dumas methods, just as it caused low results in the effusion method as described in this paper. H. H. Ho.

**2235. Vapour Pressures of Diethyl Selenide, Tetramethyl Tin and Tetramethyl Lead. Y. Tanaka and Y. Nagai.** *Imp. Accad. Tokyo, Proc.* 5. *pp.* 78–79, *Feb.*, 1929.

The vapour pressures were measured by the statical method. The results obtained are shown in the accompanying table:—

| Temperature (°C.). | Diethyl Selenide. mm. Hg. | Tetramethyl Tin. mm. Hg. | Tetramethyl Lead. mm. Hg. |
|---|---|---|---|
| 25·0 | 28 | 112 | 31 |
| 35·0 | — | 168 | 51 |

**2236. Vaporisation under the Influence of an Electric Field. E. Greibach.** *Univ. Pittsburgh, Bull.* 25. *pp.* 57–63, *Oct.* 25, 1928.

A discussion of the effects of an electric field on the evaporation of solids. The potential energy of the molecules is the determining factor. The following effects are possible: (1) An increase in the heat of evaporation due to added potential energy of the molecules. (2) A non-homogeneous distribution of the molecules in the container. (3) A different vapour pressure. (4) An effect on the rate of evaporation. (5) A different behaviour as regards temperature for the dipole in comparison with the non-dipole molecules. As a result of a theoretical discussion it is concluded that the vaporisation of a solid is affected by a non-homogeneous electric field. The heat of vaporisation is increased by an amount too small to be measured experimentally, whilst a quite observable decrease in the rate of evaporation is created. S. G. B.

**2237. Investigations on the Critical State. Part II. Limit Curve of Ether. E. Schröer.** *Zeits. f. phys. Chem.* 140. *Abt. A.* 3–4. *pp.* 241–253, *Feb.*, 1929.

An apparatus was developed by means of which it was possible to determine the constants of state over a considerable range of volumes. By means of this apparatus the limit curve of pure ethyl ether was determined, and it was found that, within the limits of density $D = 0 \cdot 23$ and $D = 0 \cdot 29$, the change from the two-phase state to the one-phase state was independent of the mean density. The data for the critical temperature, pressure and density are:

$$T(kr) = 193 \cdot 4 \pm 0 \cdot 15^\circ \text{ C.}, \quad P(kr) = 36 \cdot 15 \text{ kg./cm.} \pm 0 \cdot 05 \text{ kg./cm.}^2,$$
$$D(kr) = 0 \cdot 265 \text{ kg./cm.}^3 \pm 0 \cdot 005 \text{ cm.}^3$$

A number of observations were made on the critical opalescence, the effects of stirring, adiabatic expansion and compression were observed, and the opalescence was considered to be due to the formation of an emulsion of the two phases which took place before the temperature of complete mixing. [For Part I see Abstract 140 (1928).] F. J. B.

**2238. Researches on the Critical State. Part III. Behaviour of Ethyl Ether on Isothermal Compression in the Critical and Hypercritical Range. E. Schröer.** *Zeits. f. phys. Chem.* 140. *Abt. A.* 5–6. *pp.* 379–390, *Feb.*, 1929.

By means of the apparatus described in a previous paper, the isotherms of pure ethyl ether at temperatures between 185° and 250° C. at a pressure of 75 kg./cm.² were determined [see preceding Abstract]. The critical constants of ethyl ether were found to be: $t_{Kr} = 194 \cdot 6 \pm 0 \cdot 3$, $p_{Kr} = 36 \cdot 7 \pm 0 \cdot 2$ kg/cm.³, $V = 3 \cdot 77 \pm 0 \cdot 02$ cm.³. These are the coordinates of the critical points from the isothermal method. The coefficient of compressibility was obtained from the diagram of state, and its dependence upon pressure was shown. The coefficient of compressibility showed a somewhat pointed maximum, at higher temperatures it became flattened, but at 250° it was still visible. The maxima of the curve of coefficients of compressibility were shown to be the maxima of aggregation formation. F. J. B.

**2239. Equation of State for Ethylene Gas. L. J. Gillespie.** *J. Phys. Chem.* 33. *pp.* 354–360, *March*, 1929.

The data of Amagat was used to calculate the constants in the equation of state of Beattie and Bridgeman for ethylene gas. In terms of atmospheres, litres per mole, $T = 273 + t^\circ$ C., $R = 0 \cdot 08206$, they are $A_0 = 6 \cdot 152$, $a = 0 \cdot 04964$, $B_0 = 0 \cdot 12156$, $b = 0 \cdot 03597$, and $c = 22 \cdot 68 \times 10^4$. The critical temperature calculated from the equation agrees to $0 \cdot 4$ % with that observed, the difference being $1 \cdot 2^\circ$; the critical pressure calculated is $3 \cdot 4$ % in error. The normal density calculated from the equation is $1 \cdot 2599$, and supports the value of Batuecas as against the figure obtained by Stahrfoss, but is lower than either of these values. F. J. B.

**2240. Thermal Properties of Carbon Dioxide in the Gaseous, Liquid and Solid States. R. Plank and J. Kuprianoff.** *Zeits. f. techn. Physik,* 10. 3. *pp.* 93–101, 1929.

The earliest available data relative to carbon dioxide are here reviewed from the thermodynamic standpoint, and are utilised for the production of new tables and diagrams for which the original paper should be consulted. A. W.

**2241. Ordinary Matter and Radiant Energy as Different Phases of one and the same Fundamental Substance. W. Anderson.** *Zeits. f. Physik*, **54.** 5–6. *pp.* **433–444, 1929.**

In this investigation it is shown how the difference between ordinary matter and light quantum gas (empty space radiation) becomes smaller with increasing pressure [see Abstract 1867 (1926)], the protons and in particular the electrons gaining more and more the character of electrically neutral light quanta. At extreme pressures, ordinary matter and empty space radiation become identical at any temperature, however low. In reply to the objection that since the radiation pressure is proportional to $T^4$, an extremely high radiation pressure at a low temperature is inconceivable, the author shows that such objection is based upon error. The importance of these results in certain problems of astrophysics is pointed out. H. H. Ho.

**2242. Thermodynamical Properties of the Electron and Atomic Theory. R. D. Kleeman.** *Phil. Mag.* **7.** *pp.* **493–504,** *March*, **1929.**

In this paper previous work [see Abstract 1928 (1929)] is considerably extended, but an endeavour is made to make the publication self-contained on account of its interest and importance. The subject-matter is treated under the following headings: Equation of State of an Electron Gas; The Velocity of an Electron in an Electronic Gas Decreases Gradually between Two Consecutive Collisions and Increases during a Collision; The Effect of the Radiation surrounding an Electron on its Kinetic Energy and on its Internal Energy; The Electric Field surrounding an Electron may undergo an Increase during which it Radiates some of its Internal Energy into Space; An Electron may Radiate in Two Ways; The Equilibrium between the Emission and Absorption by the Electrons in an Electron Gas; The Formation of Atoms; and Application to the Bohr, Lewis and Langmuir Atom. The rival theories of Bohr and Lewis-Langmuir are shown to be completely reconciled, whilst it appears that electromagnetic radiation may spread evenly in space, and may be absorbed by electrons and atoms in indefinite amounts which appear in the form of internal energy. The latter may be radiated in part or altogether into space, but only as a continuous train of waves whose energy is equal to $h\nu$. With this as basis, all radiation phenomena may be explained. H. H. Ho.

**2243. Quantum Laws and the Uncertainty Principle of Heisenberg. G. N. Lewis and J. E. Mayer.** *Nat. Acad. Sci., Proc.* **15.** *pp.* 127–139, *Feb.*, 1929.

Adduces further reasons for the statement that the second and third laws of thermodynamics may be deduced from a single statistical principle which implies that the properties of a system can be described by assuming a finite number of possible states [see Abstract 3064 (1928)]. Restates the fundamental quantum laws as follows: (1) All the phenomena of any system of finite energy may be interpreted by the assumption of a finite number of exactly determined states. (2) The transition from one state to another is instantaneous. (3) When the minimum number of states required to account for the behaviour of an isolated system has been ascertained, each state will, in the course of time, be found just as often as any other state. This restatement leads directly to the uncertainty principle of Heisenberg [Abstract 38 (1928)]. E. E. F. d'A.

## SOUND.

**2244. Tube-Correction in Sound Velocity Measurements for Gases. R. E. Cornish and E. D. Eastman.** *Phys. Rev.* 33. *pp.* 90–96, *Jan.*, and *pp.* 258–259, *Feb.*, 1929.

(1) From a critical examination it is concluded that the Helmholtz-Kirchhoff equation for the change in velocity of sound in a tube, in terms of the viscosity, thermal conductivity of the gas, diameter of the tube and frequency of the sound, is valid at the higher frequencies and larger tube-diameters usually employed in present-day measurements, but is invalid at lower frequencies and for smaller tubes. It is concluded that the system of tube-calibration by measurements with a standard gas, especially as applied in much recent work at high temperatures, is in practice particularly subject to large errors. (2) As a result of this it is suggested that the values of the specific heats of gases at high temperatures presented by Shilling and Partington are less accurate than is claimed by them. A reply is made to the criticism by Shilling and Partington of the measurements with hydrogen. W. H. Ge.

**2245. Some Properties of a Fused Silica Tuning Fork. E. A. Harrington.** *J.O.S.A. and R.S.I.* 18. *pp.* 89–95, *Feb.*, 1929.

The logarithmic decrement, the coefficient of damping and the coefficient of stiffness of a fused silica tuning fork were determined from data obtained from photographic records of the vibrations of the tuning fork after it had been struck with a pianoforte hammer. Several years ago A. G. Webster exhibited a fused silica tuning fork at a meeting of the National Academy of Sciences which aroused considerable interest among the physicists who examined it. Apparently very few fused silica tuning forks have ever been made, and a review of the literature has failed to show any data on them. It seems desirable, therefore, to publish the observations which were obtained for the purpose of calculating some of the physical properties of Webster's tuning fork, even after this lapse of time. Author.

**2246. Pressure Distribution in a Fluid. N. W. MacLachlan.** *Roy. Soc., Proc.* 122. *pp.* 604–609, *Feb.* 4, 1929.

A mathematical analysis of the pressure distribution in a fluid due to the axial vibration of a rigid disc, with an application to loud speakers. The width of the central beam decreases with increase in the frequency of vibration, and also with increase in the diameter of the disc. For uniform pressure distribution over a hemispherical surface the disc ought to approximate to a point source. In practice this is discountenanced owing to limitations imposed by the driving agent due to the relatively large amplitude required to radiate the lower frequencies. If a disc 1 cm. in radius were driven by an annular coil in a radial magnetic field, the back-e.m.f. due to the motion of the coil at frequencies below 200 Hertz would cause considerable reduction in the current, and, therefore, in the force on the disc. E. E. F. d'A.

**2247. High-Frequency Sound Waves. F. L. Hopwood.** *Journ. Sci. Instruments*, 6. *pp.* 34–40, *Feb.*, 1929.

High-frequency air waves are produced by Langevin's method, putting a massive electrode of lead and a light electrode of copper foil in contact with the two faces of a quartz disc, and applying an alternating potential difference of 20,000 volts. The quartz disc dilates and contracts. A beam of air waves is formed at right angles to the disc. If this be horizontal, the formation of stationary wave-striæ can be observed in coke-dust laid on glass in the path of the beam. Interference-patterns, diffraction-effects, attenuation and the pressure of sound radiation are also demonstrated. These waves kill fish, as Langevin showed. They also break up red blood corpuscles, inhibit the electrical stimulation of a muscle-nerve preparation, destroy the structure of fresh-water vegetation. If the beam be directed upwards in oil, a mound of oil is raised on the surface; this is in strong vibration, and this vibration can be communicated to liquids in test-tubes. The air dissolved in these liquids is liberated in bubbles. Calorific effects are easy to obtain. A. D.

**2248. Echo in an Enclosed Space. K. Schuster and E. Waetzmann.** *Ann. d. Physik*, 1. 5. *pp.* 671–695, *March* 12, 1929.

A theoretical treatment of the determination of the duration of echo in an enclosed space, and its bearing on the acoustical properties of balls. W. H. Ge.

**2249. Density of Sound in a Spherical Space. K. Schuster.** *Ann. d. Physik*, 1. 5. *pp.* 696–700, *March* 12, 1929.

Theoretical treatment of a special case along the lines of the former paper [see preceding Abstract]. W. H. Ge.

**2250. Transmission of Sound through Wall and Floor Structures. V. L. Chrisler and W. F. Snyder.** *Bureau of Standards, Journ. of Research*, 2. *pp.* 541–559, *March*, 1929.

A report of the work on sound transmission through (1) a large number of masonry walls and floors and other materials which are homogeneous in construction, the results showing that weight is the most important factor under these conditions; (2) a few compound walls and floors which have a masonry core, and (3) a few stud walls. The results are given for five frequency bands covering a range from 250 to 3365 cycles per second. Transmission tests were also made for impact noises. Specifications for the construction of the various panels used are appended. Authors.

**2251. Kundt's Tube Dust Figures. Parts I and II. E. J. Irons.** *Phil. Mag.* 7. 523–537, *March*, 1929.

A summary of the various powdered substances which yield good dust figures on vibrating bodies, and a series of photographs of Kundt's tube dust figures obtained under various conditions. The theory and the difficulty of experimentally realising the theoretical conditions are discussed. W. H. Ge.

**2252. Effect of a Finite Baffle on the Emission of Sound by a Double Source. M. J. O. Strutt.** *Phil. Mag.* 7. *pp.* 537–548, *March*, 1929.

A theoretical discussion of the problem of determining the best dimensions for the baffle plate of a loud speaker. A comparatively simple model is treated in detail, and the results are presented graphically. W. H. Ge.

## ELECTRICITY AND MAGNETISM.

### THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

**2253. Structure of an Electron. Part. I. U. Kakinuma.** *Phys. Math. Soc. Japan, Proc.* 10. *pp.* 235–242, *Dec.*, 1928. *In English.*

The author outlines an attempt to connect electricity and gravitation, using the general theory of relativity and adopting rather different assumptions from those usually employed. Instead of writing for the electromagnetic energy tensor, $E_j^k = -F_{j\alpha}F^{k\alpha} + \frac{1}{4}g_j^k F_{\alpha\beta}F^{\alpha\beta}$, the expression employed is $E_{jk} = -Eu_j u_k + \frac{1}{2}g_{jk}E$, $u^k$ being the velocity vector of the charge and E being equated to $-$ or $+\ k_\alpha J^\alpha$. Weyl's vector field $\psi_j$ (which *he* identifies with the electromagnetic potentials) is put in the present theory equal to $\frac{1}{2E}\frac{\partial E}{\partial x_j}$. By suitably choosing the gauge system it is then possible to have in the initial space gravitational and electromagnetic phenomena both perceivable whilst in the transformed space the latter are incapable of being recognised. The fundamental aspects are dealt with in the present paper; applications to the case of an electron, etc., are to be given later. W. S. S.

**2254. Electromagnetic Field of an Electron. Electron as a Gravitational Phenomenon. D. Meksyn.** *Phil. Mag.* 7. *pp.* 425–434, *March*, 1929.

An electron is regarded as a neutral mass or energy characterised by a gravitational field whose potential is $m/r^2$; there are no stresses in the field of an electron. An electron does not possess an electric field. The law of energy for an electron is not satisfied for accelerated motion. The gravitational potential is deduced in the form $\Omega = -Ke^2/4r^2c^2$, which is half that deduced by Jeffrey, owing to the abolition of stresses in the present theory. Two or more electrons in space produce an electromagnetic field due to the increase or decrease of the energy of space above or below the sum of the energies of the two electrons. There is no mechanical interaction between an electrostatic and a magnetostatic field.

J. S. G. T.

**2255. Revised Value of e/m from the Zeeman Effect. H. D. Babcock.** *Mt. Wilson Observat. Contrib. No.* 374. *Astrophys. J.* 69. *pp.* 43–48, *Jan.*, 1929.

With the aid of recent data on the structure of the spectra of Cr and Ti the value formerly derived for the specific charge of the electron has been revised. The previous list of 116 lines is now reduced to 48, with only such lines retained as may properly be used according to the present theory of the Zeeman effect. The lines now employed are those which had the greatest weight in the earlier work. Forty-eight new values of $e/m$ are derived whose weighted mean is $e/m = (1 \cdot 7606 \pm 0 \cdot 0012) \times 10^7$ e.m.u./gm. This is practically the same as the earlier result [see Abstract 531 (1924)], but somewhat more reliable. AUTHOR.

**2256. Phenomena of Projected Electrons. T. J. I'a Bromwich.** *Phil. Mag.* 7. *pp.* 470–476, *March*, 1929.

The theory of the Bucherer experiment for determining $e/m$ is discussed.

The author regards it as not unreasonable that, at the slit of the condenser from which the electrons emerge, $v = c$, the velocity of light, and shows that the statement, that $v = c$ involves infinite energy, is misleading. Particles ejected from the radioactive body with a velocity $v > c$ move with velocity $c$ between the plates of the condenser. The author suggests that preference for the Lorentz formulæ rests on an appeal to the simplicity and elegance of the pure mathematics of the Lorentz theory. J. S. G. T.

**2257. Piezoelectric Effect of Diamond. W. A. Wooster.** *Min. Mag.* 22. *pp.* 65–69, *March*, 1929.

Diamonds were examined for piezoelectric effect, pressure (300 grammes) being applied by an electromagnet, thereby minimising any movement. The diamonds used were plates with the large faces parallel to the octahedron; one was isotropic, the other showed anomalous double refraction in polarised light. No piezoelectric effect could be detected. The sensitiveness of the apparatus was such that if there is any it is less than 1/200th of that of quartz. C. A. S.

**2258. Diurnal Variation of Electric Potential Gradient. F. J. W. Whipple.** *Roy. Meteorolog. Soc., J.* 55. *pp.* 1–13; *Disc.*, 13–17, *Jan.*, 1929.

For each area of 10° latitude and 30° longitude between 60° N. and 60° S. around the globe the author calculated the proportion of land. Using Brooks' maps of thunder frequency over the globe, the effectiveness of each area in producing thunderstorms was found for (1) the northern summer, (2) the southern summer and (3) the year. The relative frequency during the day of thunderstorm areas for each two hours is next found. The range of variation of these areas is greater in the southern summer, and the principal maximum is rather later in the northern than in the southern summer, but the time of the minimum is practically the same for both. The mean potential gradient is next calculated for each hour as a percentage of the day, and the values are tabulated for four stations. There is good agreement between potential gradient and thunderstorm statistics, especially in the southern summers. The investigation gives support to Wilson's theory of atmospheric electricity. In the *Discussion*, **Simpson** said that atmospheric conductivity is too weak to give the current required and turbulence does not always exist in clouds, while diurnal variations in the Heaviside layer should mask that due to thunderstorms. **R. A. Watson Watt** stated that data regarding atmospherics support the Wilson theory and the views of the author. R. S. R.

## DISCHARGE AND OSCILLATIONS.

**2259. Initial Stages Preceding the Formation of the Glow Discharge. F. Tank and K. Graf.** *Helv. Phys. Acta*, 2. 1. *pp.* 33–37, 1929. *In German.*

The phenomena are investigated which occur in a discharge tube immediately before the onset of the glow discharge in the rare gases. The application of a suitable potential difference to such a discharge tube is not followed immediately by a glow discharge, but only after a definite interval of time. The results are explained in terms of a space charge which is built up during this interval. F. J. W.

**2260. Kipp Effect in Spark Discharges. F. Kirschstein.** *Arch. f. Elektrot.* 21. *pp.* 473–476, *Feb.* 15, 1929.

During investigations of spark discharges by means of the kathode-ray oscillograph Rogowski and Tamm observed in some cases oscillatory effects across the spark gap [see Abstract 2481 (1928)]. In the present paper a theoretical discussion of such effects is given. It is shown that the characteristic for the arrangement used is essentially similar to that for an arc. This leads to formulæ from which the oscillation period can be calculated. The results obtained are in good agreement with the observed values. A. W.

**2261. Passage of Electric Current through a Cooper-Hewitt Mercury Lamp. S. Ray.** *Zeits f. Elektrochem.* 35 *pp.* 89–93, *Feb.*, 1929.

The uni-directional conductivity of the Cooper-Hewitt mercury lamp is accounted for by the influence of residual traces of gas which are absorbed by the mercury surface. The nuclear charge of the mercury atom causes the binding of additional electrons of the gaseous molecules in its electron shell whereby the hypothetical compound Hg Z is formed. On applying a sufficiently great negative potential to the mercury the negatively charged Z atoms are repelled, and finally escape as bubbles from the surface of the mercury and migrate with a surrounding shell of mercury to the anode. After liberation of the charge the mercury is repelled from the anode and returns surrounded by an adsorbed layer of gas to the kathode when the process is repeated. The fall of density of mercury vapour away from the kathode and that of gas from the anode follows an exponential law. On reversing the polarity of the electrodes the disturbance of this distribution leads to the transient small current which is observed, while the repulsion of the gas from the electrode in the gas space which is now kathode leads to a complete vacuum in its neighbourhood when the glow and conductivity cease. The phenomena which this hypothesis accounts for include the electrical " distillation " observed in mercury lamps, the occasional fall of conductivity on prolonged operation which is restored by standing and the luminosity which has been observed during the operation of the mercury diffusion pump. This hypothesis is further in accordance with the theory of Compton that the greater part of the glow discharge arises from excitation of neutral atoms by electron impacts. An expression is derived on the basis of the work of repulsion to give the relation between minimum arc voltages and the size of the gaseous aggregates or atoms. J. N. P.

**2262. Rutherford's Alternating Field Method of Determining the Velocity of Gaseous Ions. H. Mache.** *Akad. Wiss. Wien, Ber.* 137. 2*a*. *Nos.* 9–10. *pp.* 607–619, 1928.

Shows that if the field is constantly reversed by means of a commutator, so that there is a pause between the field in the positive direction and the reversed field, the velocity of the ions can be determined without any disturbance due to their inertia. Studies the disturbances due to inertia which result when the two phases follow one another instantaneously without any pause on reversal. The ion in consequence of its inertia does not return to the plate from which it has been separated photoelectrically, but swings away from it and towards it with diminishing amplitude. When the field follows the sine law, as in Rutherford's experiments, inertia effects may occur, but the author's mathematical treatment shows that in a high-frequency field they are not capable of being measured macroscopically. Part II of the paper deals with the charging of the alternating field condenser. H. N. A.

**2263. Effect of Admixture of Amines on the Mobility of Ions in Hydrogen. L. B. Loeb and K. Dyk.** *Nat. Acad. Sci., Proc.* 15. *pp.* 146–156, *Feb.*, 1929.

In some gaseous mixtures there is no change in the fundamental nature of the ion, while in other cases there are changes, such as a change in ionic dimensions (statistical clustering), or a change due to the formation of a new ion. In the latter type of change, the admixture of the first trace of foreign gas abnormally decreases the mobility of the ions. One of the most striking of such cases is the admixture of ammonia with air or hydrogen. It was, therefore, determined to investigate the effects of the addition of amines on the mobilities of ions in hydrogen, since by using different amines the size of the molecule could be varied without markedly changing the electrochemical properties of the gas. The amines used were methylamine and N-propylamine.

The latter was found to add to both positive and negative ions, even when present in very small traces, producing a large decrease in the mobility.

In the case of methylamine only, the mobility of the negative ion was affected. This indicates that if the methylamine attaches itself to the positive ion it forms a cluster of the same size as the molecule of impurity to which the positive ion in hydrogen usually attaches itself. The mobility of the negative ion is nearly as low as that of the positive ion usually observed in hydrogen. A note is added on the conditions which would have to obtain for the simultaneous observation of more than one mobility in a gaseous mixture to be possible. A. C. M.

**2264. Ionic Mobilities by the Erikson Method. J. J. Mahoney.** *Phys. Rev.* 33. *pp.* 217–228, *Feb.*, 1929.

Measurements of the mobilities of ions in air, and in air mixed with known quantities of other gases, were made by the Erikson air-blast method [see Abstracts 197 (1927) and 170 (1928)] under conditions in which the nature of the purity of the gas could be reasonably controlled. The results obtained show that there is no ageing effect as observed by Erikson in air dried over $P_2O_5$ and liquid air, or even in air passed slowly over $CaCl_2$. In these two cases the normal positive and negative ionic mobilities are observed. If air from the room of 60 % or 90 % relative humidity at 20° C. is used the ageing effects are observed. From the above and from results obtained with air admixed with various quantities of HCl, $NH_3$ or $C_2H_2$ it is concluded that the ageing of positive ions in dry air in general proceeds very much more rapidly than Erikson assumes, and possibly consists in the attachment of the initial positive ion to a bulky molecule of some impurity present. Water vapour and $NH_3$ inhibit this action either by forming groups which delay attachment to molecules of impurities present, or by removing the latter. Thus Erikson's ageing effects do not appear to be the true ageing but rather retarded ageing effects due to the action of water vapour or other substances. A.W.

**2265. Recombination of Ions in Air. P. J. Nolan and C. O'Brolchain.** *Roy. Irish Acad., Proc.* 38. *pp.* 40–59, *Feb.*, 1929.

The linear recombination law for small ions is shown to be approximately true, but the recombination coefficient between charged nuclei and small ions is not constant. This is not due to a variation of the dust content. The recombination coefficient between small ions and nuclei increases as the concentration of the nuclei decreases, and the coefficient appears to vary inversely as the square root of the nucleus concentration.

E. E. F. d'A.

**2266. Ionisation of Gases by Positive Ions. R. M. Sutton.** *Phys. Rev.* 33. *pp.* 364–372, *March*, 1929.

With a tube of simple design, positive ions of potassium are driven by controllable accelerating potentials up to 750 volts into neon and argon at various pressures. Small collecting potentials are adjusted in such a way as to eliminate practically all secondary effects due to the ions, enabling the collection of any electrons liberated by ionisation in the gases. Pressure ranges between 0·05 and 1 mm. give definite variation of ionisation with pressure. Curves are given showing the variation of ionisation with pressure and the number of new ions formed per positive ion per cm. path reduced to 1 mm. pressure. Ionisation by this process does not offer a sharp initial point, but a measurable amount is present in neon at 100 volts, and in argon between 100 and 150 volts. The efficiency of the effect is decidedly less than for electron bombardment in these gases; it is several fold greater in argon than in neon. In neither gas has the efficiency reached a maximum at 750 volts, although there is evidence in the case of argon that the maximum efficiency may be found at a slightly higher accelerating potential. The pressure range within which the ionisation effect shows itself is higher than should be expected from kinetic theory, which seems to indicate the presence of long mean free paths for the positive ions in accord with results of other observers using magnetic analysis apparatus.

AUTHOR.

**2267. Attachment of Electrons to the Molecules HCl and $NH_3$. V. A. Bailey and A. J. Higgs.** *Phil. Mag.* 7. *pp.* 277–286, *Feb.*, 1929.

Uses the method described by Bailey in a previous paper for experiments with dry air, and which has since been employed for a number of other gases [see Abstract 361 (1926)]. HCl gas was dried for a long period over concentrated $H_2SO_4$, which proved more satisfactory than $P_2O_5$. If $Z$ is the intensity of the electrical field employed and $p$ the pressure of the gas, it is found that, for $Z/p$ greater than 8, the mean energy of agitation of an electron in HCl, in terms of the mean energy of a molecule, is much lower than in all the common gases so far examined, $H_2$, $N_2$, $O_2$, $CO_2$, CO, NO, $N_2O$ and $NH_3$. The number of negative ions formed by the attachment of electrons to molecules, when $n$ electrons move a distance $dz$ in the direction of Z, is $\alpha ndz$; values of $\alpha$ have been calculated for certain values of $Z/p$. Assuming a value of the mean free path deduced from the viscosity of HCl, the value of $\lambda$, the fraction of their energy lost by electrons in collisions with molecules, is roughly estimated as 59 %, and that of $h$, the probability of attachment, as $7 \times 10^{-13}$. Certain anomalies were met with in the measurements with $NH_3$, and it is proposed to re-examine this gas with a new instrument. The results obtained for HCl and $NH_3$ indicate a certain correspondence between $h$ and the electric moment of a molecule, as deduced from variations of the dielectric constant with temperature.

H. N. A.

**2268. Electron Scattering in Helium. E. G. Dymond and E. E. Watson.** *Roy. Soc., Proc.* 22. *pp.* 571–582, *Feb.* 4, 1929.

The work here described is substantially a repetition of previous work [see Abstract 1859 (1927)], attention being concentrated on a narrow range of initial conditions. Velocity distribution curves are given for initial velocities of 102, 226 and 386 volts and for a scattering angle of 10°. For each curve, besides the peak corresponding to elastic collisions, two others appear, due to excitation and ionisation of the atom respectively. That due to excitation is compounded of several, representing the various energy states. It reaches its maximum value at 21 to 22 volts, which indicates that the excitation of the triplet system, which requires 19·8 volts, is very small or completely absent at these high velocities. Curves are also given for the angular distribution of scattered electrons for (*a*) elastic and (*b*) inelastic collisions. It is seen from the curves that at large angles many more elastically reflected electrons occur than inelastically reflected electrons, while they approximate to equality of number for smaller angles. The results are discussed. A. W.

**2269. Temperature Dependence of Field Currents. R. A. Millikan and C. C. Lauritsen.** *Phys. Rev.* 33. *pp.* 598–604, *April*, 1929.

This paper contains a full presentation of the reasons for believing, contrary to results recently obtained elsewhere, that field currents are only independent of temperature up to about 1100° K, and that at that temperature the energy of thermal agitation begins to assist the fields appreciably in causing the escape of electrons from metals. The precise form of function describing this dependence is not accurately determinable experimentally, but the form originally suggested by us fits the facts of observation thus far known satisfactorily, not better, however, than does the theoretical form suggested by Houston. AUTHORS.

**2270. Internal Exit Work for Electron Emission of Silver. J. M. Adams.** *Zeits. f. Physik*, 52. 11–12. *p.* 882, 1929.

The relation between the photoelectric long-wave limit and the external and internal exit works dealt with by Rosenfeld and Witmer [see Abstract 265 (1929)] breaks down, apparently, for silver as the number of conducting electrons per atom required equals 3, against the generally accepted valency of silver equal to 1. The author draws attention to a number of silver compounds in which the metal exhibits divalency or trivalency. The anomaly is therefore only apparent. W. S. S.

**2271. Stability of the Closed System (Rumpf) of the Silver Atom. J. Kaplan.** *Zeits. f. Physik*, 52. 11–12. *p.* 883, 1929.

Commenting on a note by Adams [see preceding Abstract], the author points out that the monovalency of silver corresponds to its very stable closed shell of ten 4d electrons outside which a single electron rotates. The necessity of assuming three conduction electrons for silver shows therefore that the stability of the system with respect to the breaking off of electrons in the conduction process is different from the stability in chemical reactions. W. S. S.

**2272. Laws of Complete Photoelectric Emission. R. Suhrmann.** *Zeits f. Physik*, 54. 1–2. *pp.* 99–107, 1929.

The complete photoelectric emission, *i.e.*, the total electron emission, when a metal surface is illuminated with the black body radiation corresponding to a given temperature, can either be determined directly by experiment or it can be computed from the Planck energy distribution law and the photoelectric sensitivity curve for different wave-lengths. The second method does not involve the uncertainties of temperature *measurement* and is used by the author to calculate $i$ the complete emission as a function of temperature. Writing $i = AT^{\gamma}e^{-w/T}$, for platinum and gold, $r$ is found to equal about 3·8, the photoelectric sensitivity curves determined previously by the author being used in the calculations. Using this value of $r$, $n$ and, from this, $\nu_0 = n/h$ were determined. $\nu_0$, the long-wave limit determined in this way, was found to be slightly higher than $\nu'_0$, the value determined by direct experiment. ($\nu'_0$ is involved in the calculations leading to $\nu_0$, but a slight error in $\nu'_0$ has no appreciable effect on $\nu_0$.) The discrepancy is regarded as due to the fact that a few photoelectrons may, even at room-temperature, be on the point of emerging owing to heat energy. W. S. S.

**2273. Effect of the Level from which "Photoelectrons" Originate on the Distribution in Space of their Initial Directions. P. Auger.** *Comptes Rendus*, 188. *pp.* 447–450, *Feb.* 4, 1929.

Considers the electrons liberated from the interior levels of heavy atoms (xenon) by bombardment with monochromatic X-rays. Curves have been constructed showing the relation between the density of emission D and the angle $\omega$ at which the electrons are given off; also the total number N of electrons observed between o and $\omega$. The distribution in the case of the K level of xenon depends on $\sin^3 \omega$, as is the case when the energy of the level is negligible. In the case of the L level, the form of the D, $\omega$ curve differs greatly from the above; it approximates to the $\sin \omega$ curve, and indicates a supplementary dispersion. It is suggested that this is due to the momentum of the electrons before emission, which combines haphazard with that due to the "photoelectric" impulse. The electrons from the K level behave as though they have no momentum before the X-ray quantum acts on them. H. N. A.

**2274. Photoelectric Effect of Ultra-Violet Light on Gases. R. Dantienne and P. Lenaerts.** *Arch. des Sciences*, 11. *pp.* 5–14, *Jan.–Feb.*, 1929.

Studies the ionisation of dried and filtered oxygen, air, carbon dioxide and sulphur dioxide by a spark discharge between aluminium electrodes. Finds that the ionisation shows a behaviour parallel to the photoelectric effect in metals plunged in the same gases, and concludes that this effect is really due to the ionisation of gases occluded at the metallic surfaces. E. E. F. d'A.

**2275. Thallium Photo-Conducting Cells. Q. Majorana and G. Todesco.** *Accad. Lincei, Atti*, 8. *pp.* 9–14, *July*, 1928.

Gives detailed instructions for constructing photo-conductors of the "thallofide" type. Thallous sulphide is spread on a sheet of ground glass and gradually heated in air until it suddenly turns a darker shade and adheres to the glass. It is spread thin by means of a glass spatula. It is then slowly cooled. Tinfoil or copper electrodes are then attached, and the plate is enclosed in an air-tight glass bulb. E. E. F. d'A.

**2276. Experiments on the Polarisation of Electron Waves. E. Rupp.** *Zeits. f. Physik*, 53. 7–8. *pp.* 548–552, 1929.

This is a brief account of experiments undertaken with the idea of trying to ascertain whether electron waves are polarised. Only negative results were obtained. Electrons of moderate velocity (120 to 380 volts) were reflected twice from single copper crystals using the (1, 1, 1) plane. The reflected electron beam showed no selective maxima depending on the rotation of the second reflector. The earth's magnetic field was carefully neutralised. A diagram of a convenient form of electron tube is given. Davisson and Germer's experiments (*Nature*, p. 809, 1928) and the work of Wolf [see Abstract 1645, (1929)] are referred to. T. B.

### 2277. Axial Symmetric Electromagnetic Waves Propagated along the Axis of Symmetry. N. S. Japolsky. *Zeits. f. Physik*, 54. 1–2. *pp.* 108–122, 1929.

The writer discusses mathematically axial wave fields in which the electric and magnetic vectors obey Maxwell's equations, and for which the direction of propagation is parallel to (not, as in the usual case, perpendicular to) the axis of symmetry. It is shown that there exist waves of this character which are propagated without change of form, and that it is not theoretically impossible for them to arise by radiation from a source of finite dimensions. W. S. S.

### 2278. Reflection and Transmission of Electric Waves at the Interface between Two Transparent Media. H. M. Macdonald. *Roy. Soc., Proc.* 123. *pp.* 1–27, *March* 6, 1929.

Approximate expressions are obtained for the electric and magnetic forces in the transmitted and reflected waves, when the primary wave is incident on the interface between two media, the surface of separation being any surface. The assumption underlying the analysis is that the principal contributions to the electric and magnetic forces in the transmitted and reflected waves are due to magnetic and electric distributions on the interface which at any point are such that they would produce the electric and magnetic forces in the immediate neighbourhood of the point if the surface were a plane surface. W. S. S.

## ALTERNATING CURRENTS AND MAGNETISM.

### 2279. Vacuum-Tube Circuit for Measuring Small Alternating Currents. R. E. Martin. *J.O.S.A. and R.S.I.* 18. *pp.* 58–61, *Jan.*, 1929.

Four vacuum tubes are so arranged in a circuit that for each direction of the e.m.f. the current through a d'Arsonval galvanometer is unchanged. The electron current due to the heated filaments is just compensated by a battery. The theory of the circuit is given, and it was tested against a Duddell galvanometer down to currents of $10^{-7}$ ampere. The arrangement will measure these currents at low frequencies accurately, and at high frequencies the error is only a few per cent. when proper corrections are applied. The circuit has been used to measure currents of $10^{-9}$ ampere. R. S. R.

### 2280. Transformations in Alternating Current Theory. B. van der Pol. *Phil. Mag.* 7. *pp.* 477–488, *March*, 1929.

The imaginary part of an impedance may have a positive as well as a negative sign. As long as positive resistances only were known, the real part of an impedance was always positive; but with the advent of negative resistances (such as the arc, the dynatron or the triode with retroaction), the real part of an impedance, like the imaginary part, may have both signs. We may transform by multiplying by $j, j^2, j^3, j^4$, where $j = \sqrt{-1}$. We might use $j^n$, where $n$ is a non-integral number; but we do not consider that here. Multiplying by $j^4$ restores the circuit. Multiplying by $j^2$ replaces every positive resistance by an equal but negative resistance, and every positive capacity by a negative, and *vice versâ*. We can, with the aid of two positive and one negative resistance and a capacity construct a negative inductance independent of frequency; we can also construct a negative capacity. We can therefore realize the new circuit, adjusting it for stability.

Multiplying by *j* (note that $j^3 = -j$). As the reactance of a self-induction and of a capacity depend upon the angular frequency $\omega$ of the impressed e.m.f., the *j*-transformation can be used only for one frequency at a time. Every positive resistance R is transformed into an inductance L′, of amount $L' = R\omega^{-1}$; every negative resistance $-$ R into a capacity $C' = (\omega R)^{-1}$. Every inductance L has to be replaced by a negative resistance $-R' = -(\omega L)^{-1}$. Every capacity C has to be replaced by a resistance $R' = (\omega C)^{-1}$. A number of a.c. circuits are considered and are subjected to a *j*-transformation. In particular, the circuit in Fig. 1 is replaced by that in Fig. 2.

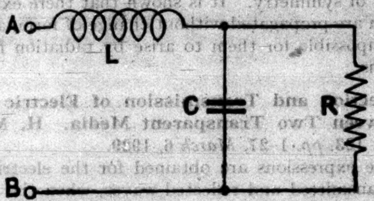


Fig. 1.

In the former, the amplitude of the current through the L branch is unaffected by the value of R, but its phase is. In the latter, if we apply an e.m.f. of any complicated wave-form to the terminals A′B′, all the amplitudes of the various harmonic components of the current entering at A′ will be exactly proportional to the corresponding amplitudes of the harmonics of the e.m.f.; the phases of the currents are, however, shifted relative to the phases of the e.m.f., and by an amount depending on the frequency. This gives a means of verifying experimentally the acoustic law of Ohm, that our ear perceives from a complicated sound the amplitudes of the various components only, but cannot recognise the phases of these components. The oscillograms give very different forms in the two cases, but not the slightest difference in the sound can be perceived.

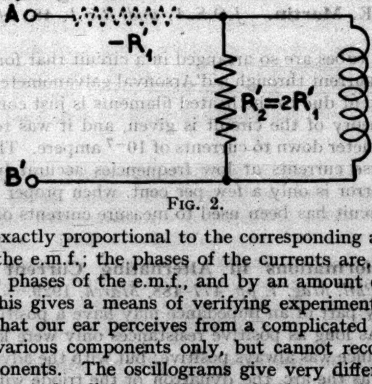


Fig. 2.

A. D.

**2281. Anomaly in Gaseous Diamagnetism. H. Buchner.** *Ann. d. Physik,* 1. 1. *pp.* 40–48, *Jan.* 2, 1929.

An abnormal increase in the susceptibility of diamagnetic gases at low pressures was described by A. Glaser [see Abstract 607 (1925)], and a possible explanation is put forward, namely, a miscalculation of the temperature correction for the susceptibility of Glaser's test bar. Measurements are given in support of the author's view. G. E. A.

**2282. Coercive Force and Mechanical Hardness. A. Kussmann and B. Scharnow.** *Zeits. f. Physik*, 54. 1-2. *pp.* 1–15, 1929.

A study of the relationship between the coercive force (magnetic hardness) and the mechanical hardness of alloys and their dependence upon the structure of the alloys. It is shown that in the case of solid solutions (mixed crystals) in which the variation of the space lattice causes the mechanical hardness, the electric resistance, etc., strongly to increase in value in comparison to the pure metal, the coercive force is only inconsiderably altered, and that no direct relationship exists between the coercive force and the mechanical hardness of the alloy. The coercive force is shown to exhibit a strong increase in the case of heterogeneous mixtures where it is independent of the hardness. An explanation is given of the above through the assumption of an effect on the ferromagnetism due to the tension created by contraction, which is primarily created by the different thermal expansion coefficients of the constituents of the mixture. The paper is complete with experimental and theoretical details. S. G. B.

**2283. Curious Gyroscopic Phenomenon. Charron.** *Comptes Rendus*, 188. *pp.* 482–484, *Feb.* 11, 1929.

Suppose a top is spinning rapidly of which the axis is composed of a magnetic rod of linear dimensions. The magnet is vertical with its North pole uppermost. Slowly approach this spinning magnet with another North pole of a similar magnet held in the hand. The axis of the top immediately inclines in a manner so that there is apparently a force of attraction between opposite poles in a straight line between them. This seemingly paradoxical result is discussed mathematically and is completely explained. S. G. B.

**2284. Magnetic Susceptibilities of several Organic Gases. F. Bitter.** *Phys. Rev.* **33**. *pp.* **389–397**, *March*, **1929**.

A method for measuring the magnetic susceptibilities of gases similar in principle to that used by Wills and Hector but simpler in operation was developed. The following results given in molecular susceptibility × $10^6$ were obtained: methane ($CH_4$), − 12·2; ethane ($C_2H_6$), − 27·3; propane ($C_3H_8$), − 40·5; butane ($C_4H_{10}$), − 57·4; isobutane ($C_4H_{10}$), − 56·3; ethylene ($C_2H_4$), − 12·0; acetylene ($C_2H_2$) − 12·5; using as standards $H_2$, − 3·94 and $N_2$, − 11·8. These values are in error by less than 4 per cent. relative to each other. It is shown that these results cannot be reconciled with the assumption that the susceptibility of one of these molecules is equal to the sum of the susceptibilities of the atoms of which it is made up. The hypothesis is suggested that the susceptibilities of these substances are determined by the binding electrons, and it is shown that this assumption leads to a satisfactory interpretation of the observations if the two $CH_2$ groups of ethylene are supposed held together by electrostatic forces, and the two CH groups of acetylene by a bond similar to the ordinary C-C bond, such as in the $C_nH_{2n+2}$ molecules. It is shown that among the previous measurements of the susceptibility of $H_2$ and $N_2$ those made by Wills and Hector are probably the most nearly correct. AUTHOR.

**2285. Measurement of the Horizontal and Vertical Intensity of the Earth's Field with a Magnetron. M. Rössiger.** *Zeits. f. Instrumentenk.* 49. *pp.* 105–113, *March*, 1929.

The magnetron is placed axially within a coil carrying a current of the strength necessary to reach the steeply descending part of the characteristic curve (anode current-applied field) for which the valve is sensitive to small changes of field. The coil and valve are placed on the axis of a Helmholtz double coil, and the whole can rotate about horizontal and vertical axes. On rotating the horizontal filament about a vertical axis, the anode current passes through maximum and minimum values, namely, when the earth's field H acts respectively against and with the applied field. When the apparatus is in the position for maximum current, the application of a field 2H by means of the Helmholtz coils reduces the anode current to its minimum value, and the numerical value of H is obtained from the current and constants of the Helmholtz coils. Similarly with the V component. Various sources of error are discussed. When the apparatus was tested at Potsdam the error in the mean value of H was $-10\gamma$, and that in V was $-30\gamma$. [See also Abstract 2990 (1927).]

G. E. A.

**2286. Variability of the Quiet-day Diurnal Magnetic Variation at Eskdalemuir and Greenwich. S. Chapman and J. M. Stagg.** *Roy. Soc., Proc.* 123. *pp.* 27–53, *March* 6, 1929.

The investigation is based on data comprising the daily range of variation in the magnetic elements on very quiet days as measured at Eskdalemuir and Greenwich in the well-developed sunspot-cycle 1913–23. By working with yearly and monthly means, the solar-cyclic and annual changes in the daily variation were isolated and used to define a " normal " range of variation for each quiet day in the period investigated. The percentage deviation $\Delta R$ of the actual range R from the normal range $R_n$ for each day, is used to measure the fortuitous change with which the authors are principally concerned. The average numerical values of $\Delta R$ for different magnetic elements and for different seasons range from about 20 to 30 %. Close correlation between daily values of $\Delta R$ for the same element at the two observatories was observed, correlation between corresponding values of $\Delta R$ for different elements at the same observatory being much weaker. It is shown from the data that the daily variations at any particular season are adequately characterised by the range, there being no change in type with change in amplitude.

W. S. S.

## ELECTRICAL PROPERTIES AND INSTRUMENTS.

**2287. Mechanism of Asymmetric Conductivity for Imperfect Contact. R. Audubert and (Miss) M. Quintin.** *Comptes Rendus,* 188. *pp.* 52–54, *Jan.* 2, 1929.

For the Si-C couple the characteristic is given by (1) $i = aV^2 + bV$ for $V > 0$ and (2) $i = -a'V^2 + bV$ for $V < 0$. The Si particles make a pitted surface at the junction and rectification appears there. The authors show that with this junction electronic emission occurs, the current emission being given by $i = 9KV^2/32\pi l^3$, where K is the mobility of the ions. Since K is much greater for negative than for positive corpuscles, this agrees with the observed fact that the current flows more easily when C is negative compared with Si. The hypothesis of electronic emission accompanying ionisation phenomena explains the facts qualitatively and quantitatively for this imperfect contact and probably acts also as the mechanism for $Ag_2S$ and PbS. R. S. R.

**2288. Resistance-Hysteresis Phenomena of Tin, Lead, Indium and Thallium at the Temperature of Liquid Helium. W. J. de Haas and J. Voogd.** *K. Akad. Amsterdam, Proc.* 32. 2. *pp.* 206–213, 1929. *Comm. No.* 191*d from the Phys. Lab., Leiden.*

The hysteresis effects in the disturbance of superconductivity by a magnetic field have been examined in the cases of tin, indium, thallium and lead. The wires used were obtained by forcing the molten metal into a capillary tube, cooling from one end and etching away the glass. In all cases hysteresis effects appeared. With tin and indium, where there was reason to believe that the wires used consisted of very few or single crystals, the resistance varied by marked jumps—one in the case of indium. With thallium and lead the magnetic transition figures consisted of two continuous curves. C. A. S.

**2289. Superconductivity of Gallium. W. J. de Haas and J. Voogd.** *K. Akad. Amsterdam, Proc.* 32. 2. *pp.* 214–217, 1929. *Comm. No.* 193*b from the Phys. Lab., Leiden.*

The electric resistances of two samples of gallium, (*a*) containing 0·16 % indium, 0·10 % zinc, 0·01 % lead and a trace of sodium, and (*b*) 0·3 % indium, in liquid helium, were examined. Neither showed superconductivity at the temperature attained (1·1° K.), but it seemed probable that this would be indicated at a slightly lower temperature. The two samples, however, showed marked differences, (*b*) giving, in particular, a much greater decrease between 4·2° and 1·1° K. The resistances are also very sensitive to current. Impurities seem to have considerable effect, and further experiments with purer gallium are deemed necessary.
C. A. S.

**2290. Influence of a High-Potential Direct Current on the Conductivity of an Electrolyte. J. A. H. Leech-Porter and T. Alty.** *Phil. Mag.* 7. *pp.* 153–159, *Jan.*, 1929.

The conductivity of very dilute electrolytic solutions was found to vary greatly when the electrolyte was subjected to a high-potential direct current. This variation occurs only in a limited range of conductivities, and is absent when the conductivity of the solution is either too high or too low. It is most pronounced in the case of HCl solutions, in which the specific conductivity is about $2 \times 10^{-4}$ ohm$^{-1}$, and then the conductivity may vary by as much as 600 %. It seems that the high potential draws the ions from the centre portion of the liquid towards the electrodes, where they remain. If the direct current is reversed, each of these concentrated groups of ions moves across the experimental cell as a unit. This may give a method of determining the ionic mobility. J. J. S.

**2291. High-Frequency Conductivity of Aqueous Solutions of Electrolytes. H. Rieckhoff and H. Zahn.** *Zeits. f. Physik,* 53. 9–10. *pp.* 619–627, 1929.

The theory of Debye and Falkenhagen defines the conductivity of an electrolyte, which is completely dissociated and which contains two species of ions, by an equation of the form $\Lambda = \Lambda_{\infty} - (\Lambda_{I} - \Lambda_{II})\sqrt{\nu}$, where $\Lambda$ is the limiting conductivity at infinite dilution, and $\nu$ the concentration in mols per litre [see Abstract 2817 (1928)]. The theory was put to the test of experiment with high-frequency alternating current. A number of electrolytes were investigated over a wide range of concentrations. On the whole the results confirmed the theory of Debye and Falkenhagen. F. J. B.

**2292. Residual Thermoelectricity of Mercury Filaments. T. Tsutsui.** *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No.* 175. *pp.* 19–32, *Feb.* 1, 1929. *In English.*

The object of the experiments described in this paper was to study the phenomena of residual thermoelectricity obtained by local heating of mercury filaments contained in glass capillaries. The results obtained are chiefly qualitative, and the experiments were of a preliminary kind. The results show that a sensible e.m.f. can be produced by a local symmetrical heating of a small portion of a mercury filament contained in a small glass capillary. This e.m.f. is very small, unstable and irregular, and the thinner the capillary the more unstable the e.m.f. is. A definite e.m.f. merely due to the geometrical condition of the cross-section of the conductor, at least in the case of mercury, could not be obtained at the degree of accuracy of the experiments described. The cause of the e.m.f. observed is still obscure, but it seems to be connected with some of the properties of the molecular or ionic layer constituting the interface between the mercury and glass. J. J. S.

**2293. Thermoelectromotive Force in Permalloy. A. W. Smith and Joy Dillinger.** *Phys. Rev.* 33. *pp.* 398–402, *March*, 1929.

Measurements have been made on the combined effect of tension and a longitudinal magnetic field on the thermoelectromotive force in three specimens of permalloy. The specimens were in the form of wires, the composition being 78, 81 and 84 % nickel with the remaining part iron. In all cases the magnetic field produces a decrease in the thermoelectromotive force. Annealing at 1000° C. increases the change of thermoelectromotive force produced by a longitudinal magnetic field. In an alloy containing 78 % nickel tension decreases the maximal value of the change of the thermoelectromotive force. In an alloy containing 81 % nickel the maximal value of $\Delta E/E$ is relatively insensitive to tension. In an alloy containing 84 % nickel tension decreases the change of thermoelectromotive force at low magnetic fields, but increases it for magnetic fields greater than about 10 gauss. In all three cases the maximal value of $\Delta E/E$ is relatively insensitive to changes in tension beyond about 10 kg./mm.$^2$ There is a parallelism between the change of length and change of thermoelectromotive force under the combined action of tension and a longitudinal magnetic field. In high-nickel permalloys tension decreases the intensity of magnetisation for low magnetic fields, but increases the magnetostrictive contraction and the change of thermoelectromotive force. In low-nickel permalloys tension increases the intensity of magnetisation for low magnetic fields, but decreases the magnetostrictive expansion and the change of thermoelectromotive force. AUTHORS.

**2294. New Electrical Phenomenon. L. Zehnder.** *Helv. Phys. Acta,* 2. 1. *pp.* 38–45, 1929. *In German.*

On bringing a solid body near an iron-free solenoid which is rotating rapidly a current is generated in the solenoid. F. J. W.

**2295. Dipole Moments of Some Mono- and Disubstituted Benzene Derivatives. P. Walden and O. Werner.** *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 10–26, *Jan.*, 1929.

In this paper [see also Abstract 1704 (1928)] the polarisation and dipole moments of fluoro- and iodo-benzenes, *o*-, *m*- and *p*-dibromo-benzenes, *o*-, *m*- and *p*-bromo-iodo-benzenes, *o*-, *m*- and *p*-chlorotoluenes, and *o*-, *m*- and *p*-chloronitrobenzenes are recorded. The data establish that among the isomers the variations depend on the nature and positions of the substituents. For *o*-, *m*- and *p*-dibromo-benzenes, *o*-, *m*- and *p*-bromo-iodo-benzenes, and *o*-, *m*- and *p*-chloronitrobenzenes the moment changes according to the sequence $o>m>p$, whereas this is reversed in the *o*-, *m*- and *p*-chlorotoluenes, *viz.*, $p>m>o$. Based on Thomson's ideas, the moments of a large number of the above disubstituted benzene derivatives have been calculated by means of vector analysis and excellent agreement found between theory and experiment, except for the chlorophenols. In the latter case the significance of the sign of the substituent is discussed. Syrkin calculations [see *Zeits. Anorg. u. Allgem. Chem.* 174. 47. 1928] are found to be invalid. H. H. Ho.

**2296. Self-Rectifying Valve Voltmeter. C. G. Suits.** *Helv. Phys. Acta.*, 2. 1. *pp.* 3–32, 1929. *In German.*

A new type of valve voltmeter is described in which the usual anode and filament batteries are dispensed with by using low-frequency a.c. for the purpose. It is shown theoretically that the results at high frequencies are independent of the frequency of the supply, and of its phase angle. It is claimed that the voltmeter operated from a.c. mains gives results equally as good as those obtained when d.c. is used. G. E. B.

## RADIOGRAPHY AND ELECTROPHYSIOLOGY.

**2297. Two Simple Methods of Purifying Radium Emanation. W. G. Moran.** *Phil. Mag.* 7. *pp.* 399–404, *Feb.*, 1929.

A description of a relatively simple apparatus for the purification of radium emanation, the apparatus being low in cost and easy in operation. The use of liquid air is avoided and the removal of water vapour found unnecessary and, therefore, phosphorus pentoxide dispensed with. The two methods of purification adopted are: (1) The emanation and other gases are pumped from the solution and passed directly into a purifying unit consisting of a tube containing a spiral of platinum copper plated and oxidised. When heated electrically to a bright red heat it readily ignites the oxygen with part of the hydrogen and oxidises the excess hydrogen. About 10 gm. of KOH fused on a thin layer around the wall removes the $CO_2$. Experimental detail is given of the purifying unit. (2) In this method the excess hydrogen passes through a wall of heated palladium into the outside air, a spark being used to unite the oxygen and hydrogen. KOH is used to absorb $CO_2$ as before. The emanation is pumped from the solution into a single small purifying tube and from there pushed directly up into the thin-walled capillary. The emanation may be withdrawn and collected over mercury at any stage in the purification. The concentration attained compares favourably with the results obtained with more complex installations. W. V. M.

## CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

**2298. Formulæ Representing Isotherms of Adsorption. A. Boutaric.** *Comptes Rendus*, 188. *pp*. 450–452, *Feb*. 4, 1929.

The formulæ of Perrin and Freundlich are considered. The paper is of a mathematical nature, however, and does not lend itself to abstraction.
J. K.

**2299. Equilibrium of Heterogeneous Systems including Electrolytes. Part III. Effect of an Electric Field on the Adsorption of Organic Molecules, and the Interpretation of Electrocapillary Curves. J. A. V. Butler.** *Roy. Soc., Proc.* 122. *pp*. 399–416, *Feb*. 4, 1929.

Considers the effect of an electric field on the amount of substance adsorbed from a solution at a mercury surface, and the resulting variation of the depression of the surface tension. Finds that, if $\Gamma$ is the amount adsorbed with potential V at the interface, and $\Gamma_0$ the amount when $V = 0$, $\Gamma = \Gamma_0 e^{-(aV^2+bV)}$; $\Delta\gamma = \Delta\gamma_0 \,.\, e^{-(aV^2+bV)}$, where $\gamma$ is the surface tension and $\Delta\gamma$ the depression of the surface tension. The observed curves for a large number of substances, showing the relation between $\Delta\gamma$ and V, are of the general form indicated by the above equation. The values of the constants *a* and *b* have been calculated for numerous organic compounds in aqueous solution, and are discussed. The main features of Gouy's electrocapillary curves are interpreted. H. N. A.

**2300. Solutions. Part II. Freezing-Point Diagrams and Latent Heats of Evaporation of Binary Mixtures of Volatile Liquids. Part III. Transition Point of Carbon Tetrachloride, and Compounds of Carbon Tetrachloride or Chloroform with Acetone, Ether and Benzene. W. F. Wyatt.** *Faraday Soc., Trans.* 25. *pp*. 43–53, *Feb*., 1929.

Part II. Results are now given [see Abstract 320 (1929)] for the following binary systems: methyl alcohol-chloroform, ether-carbon tetrachloride, ethyl acetate-carbon tetrachloride, benzene-ethyl bromide. For the first of these the latent heat curves shows two minimum and two maximum values, but for the other systems the curves are regular. Large positive deviations from the additive law for the system, ethyl alcohol-chloroform indicate that relatively strong forces of attraction exist between the two species of molecules at high temperatures. Cryoscopic evidence is given for the existence of the compounds: $CH_3 . OH, CHCl_3$; $(C_2H_5)_2O, CCl_4$; $2(C_2H_5)_2O, CCl_4$; $2(CH_3 . CO_2C_2H_5), CCl_4$. The form of the latent heat curves for mixtures containing carbon tetrachloride indicates that the above compounds of this substance are unstable at high temperatures. Part III. The transition point, about − 48·5°, previously found for the systems $C_2H_5 . OH - CCl_4$, $(C_2H_5)_2O - CCl_4$, and $CH_3 . CO_2C_2H_5 - CCl_4$, is now observed with mixtures of acetone and of carbon disulphide with carbon tetrachloride. These and other results indicate that the break is due to the existence of the two crystalline modifications of carbon tetrachloride, and it is suggested that observations of this transition point in a binary mixture would be preferable for use as a fixed temperature in thermometry than the pure substance itself. Freezing-point curves furnish evidence of the existence of the compounds: $C_6H_6$, $CCl_4$; $C_6H_6$, $2CCl_4$; $(CH_3)_2CO$, $CCl_4$; $3(C_2H_5)_2O$, $CHCl_3$; $2(C_2H_5)_2O$, $CHCl_3$; $(C_2H_5)_2O$, $CHCl_3$; $(C_2H_5)_2O$, $2CHCl_3$. The formation of the oxygenated compounds is accounted for by supposing that a coordinate link is formed by the oxygen atom of the one substance donating a lone pair of electrons to the chlorine atom of the halogen substance. The etheric oxygen is seen to be a more powerful donor than ketonic oxygen, and the chlorine atoms of chloroform more powerful acceptors than those of carbon tetrachloride. In the case of benzene as second component, it is found that, although chloroform does not combine, carbon tetrachloride is able to form additive compounds with this substance. T. H. P.

**2301. Heitler's Theory of Concentrated Solutions. L. Vieth.** *Phys. Zeits.* 30. *pp.* 126–139, *March* 1, 1929.

A critical survey of the Heitler theory of concentrated solutions was made, and the formulæ and various assumptions were tested by the results of measurements recorded in the literature. It was found that although the Heitler theory possesses certain advantages over others, and that by virtue of the employment of molecular structure as a starting point, which lead to simple and quantitative formulæ, the theory was not tenable in its present form. The theory did not lead to the exact general results as given by experiment, although in some cases very close agreement was obtained. Further investigation of the various assumptions and closer inspection of the properties of the components will probably lead to the removal of these discrepancies. F. J. B.

**2302. Some Caseinates and the Theory of Lyophilic Colloids. M. H. Fischer and Marian O. Hooker.** *Kolloid. Zeits.* 47. *pp.* 193–206, *March*, 1929.

According to the authors' theory, here applied to the system casein-water, all lyophilic colloid systems consist of two (or more) mutually soluble substances, either both liquid under prevailing conditions, *e.g.*, potassium oleate-water, or one solid (sodium stearate-water). When such a colloid is brought into a dispersing medium, there will either be complete dissolution of the colloid in the solvent, and that will occur when the concentration of the colloid is low or the temperature high, or dissolution of the solvent in the colloid, when the colloid concentration is high or the temperature low. In columns of such liquids both states will be found, soap in water (true solution) at the top, water in soap (colloidal solution) at the bottom, and there will be intermediate layers of two mixed systems (sols and gels). It is not possible to differentiate strictly between true and colloidal solutions as regards osmotic pressure, electric conductance, etc. The experiments described in detail are made with a casein, free of ashes, containing air-dried 10 % of water and yielding clear gels with acid and alkali, and with various alkali and other salts and non-electrolytes. When there is either very little or very strongly marked mutual solubility, there is little tendency to sol or gel formation. The addition of acids or alkalies changes the solubility and the water-binding power of the casein. The important effects are specific, but are not connected with the H· or OH′ ion concentration of the electrolytes. The acids and alkalies unite with the protein under formation of salt-like compounds (casein chloride or potassium caseinate, etc.). The salt added may react either with the casein compound acid, to form a new compound differing in solubility and water-binding power, or with the solvent.

That accounts for the progessive changes in the colloidal state, increased viscosity, gel formation, synæresis and separation into a solid and liquid. Sugars, alcohol, glycerin, etc., when not affecting solubility and viscosity, do not produce deflocculation, which has little to do with the electric charges of the particles. H. B.

**2303. Kinetics of Coagulation of Gold Sols. Ann E. Davies.** *J. Phys. Chem.* 33. *pp.* 274–284, *Feb.*, 1929.

The change in behaviour exhibited by a gold sol as a consequence of it having been maintained at a fairly high temperature (80° C.) for a comparatively short period (about 4–6 hours) has been investigated. The maintenance of a sol under standard conditions at a given temperature implies ageing, and since in this case the temperature is abnormally high, the phenomenon has been termed "thermosenescence" or "thermo-ageing." Its effect at 80° C. is very pronounced and consists of (*a*) a primary effect which is a fall in the Smoluchowski coefficient $\beta$ to a minimum after about 3 hours; (*b*) a secondary effect which is the subsequent rise in $\beta$ after the minimum and fully accounted for by the influence of evaporation. Various explanations are suggested for the primary effect, which is shown to be irreversible, an important fact is that sols can be brought to an equilibrium state by merely maintaining them at a high temperature for a suitable period of time. An attempt has been made to obtain the true temperature effect on the rate of slow coagulation. The main general significance of the work is the demonstration of the necessity of first eliminating the variability due to thermosenescence in the case of measurements of any colloid property even when carried out at room-temperature. H. H. Ho.

**2304. Raoult's Law. W. D. Bancroft and H. L. Davis.** *J. Phys. Chem.* 33. *pp.* 361–370, *March*, 1929.

The application of the Raoult equation to concentrated solutions is discussed. In this equation the molecular weights are theoretically those of the two components in the vapour state, but in the equation actually used by Raoult the molecular weight of one component in the liquid phase is employed. The error has not been recognised, since in an ideal solution the molecular weights in the liquid and in the vapour are supposed to be the same. Owing to the failure to recognise the real meaning of the so-called Raoult equation, $N_1/N_1 + N_2 = p_2 - p_2'/p_2$, most of the work dealing with variations from this equation will probably have to be revised. An equation was developed empirically, by means of which a number of systems can be represented with a very high degree of accuracy. The modified equation is: $a \,.\, \log \,.\, G_1/G_2 = \log \,.\, p_2 - p_2'/p_2 + \log \,.\, K_1$, where $G_1$ and $G_2$ are the masses in grammes of the two components in the solution. This equation was tested for the binary mixtures, ethyl alcohol and water, methyl alcohol and water, methyl alcohol and acetone, water and acetone, acetone and ether, at temperatures of 20° to 30·9° C., and over a range of concentrations. F. J. B.

**2305. Distribution of Acetone through a Rubber Membrane. D. S. Morton.** *J. Phys. Chem.* 33. *pp.* 384–397, *March*, 1929.

The distribution of acetone through a rubber membrane between methyl alcohol and water was measured by two independent methods. In the first method the acetone was allowed to pass through the rubber membrane into the acetone-methyl-alcohol-water solution, and in the second method the vapour pressures of the acetone mixtures were determined. The determinations were carried out over the range 0 to 70 %, and the results agreed with the equation: $G_{ac}/G_{alc} = 2\cdot24(G_{ac}/G_{w})^{1\cdot09}$. The results indicated that the distribution of a solute between two phases is primarily a function of mass concentration. F. J. B.

**2306. Effect of Electrolytes on Emulsions. H. V. Tartar, C. W. Duncan, T. F. Shea and W. K. Ferrier.** *J. Phys. Chem.* 33. *pp.* 435–446, *March*, 1929.

Emulsions of benzene and water with sodium oleate as the emulsifying agent are destroyed by acids added in sufficient amount to effect the decomposition of the soap. Benzene-water-sodium oleate emulsions of the oil-in-water type may be inverted by addition of oleic acid to the benzene phase. The stability of emulsions produced with the help of sodium oleate as emulsifying agent is not increased by the presence of sodium hydroxide, but the type of the emulsion may be changed by using univalent electrolytes yielding the same cation as the soap. Emulsions of benzene with water and sodium oleate show a well-defined zone of stability between sodium chloride concentrations of $0\cdot25\,N$ and $0\cdot45\,N$, the inversion point shifting somewhat as the concentration of the sodium hydroxide is increased. When toluene or xylene is used in place of benzene, the inversion point is not markedly influenced by the sodium hydroxide concentration. With the water and " oil " phase used, potassium stearate is superior to sodium oleate as an emulsifying agent, the emulsions being prepared more easily and having greater stability. All the emulsions produced with potassium stearate are of the oil-in-water type, and no inversion is effected by the use of potassium chloride and potassium hydroxide. The presence of methyl groups attached to the benzene ring has a beneficial influence on the emulsifiability of the " oil." The amino-group, however, seems to exert an inhibitory influence, but two methyl groups, as with dimethylaniline, apparently overcome this inhibitory influence and emulsification takes place readily. When two different substituent groups are attached to the benzene ring, as in orthotoluidine, the influence of the amino group seems to predominate and there is no emulsification. The nitro group favours emulsification. T. H. P.

**2307. Reaction Limits, Peaks of Electric Conductance and Röntgen Interferences of Metallic Mixed Crystals. M. le Blanc, K. Richter and E. Schiebold.** *Ann. d. Physik,* 1. 3. *pp.* 318–320, *Feb.* 9, 1929.

A critique of the paper by Tammann [see Abstract 1711 (1929)] with special regard to the attack of Cu-Au alloys by nitric acid of different concentrations at various temperatures. H. B.

**2308. Reaction Limits, Peaks of Electric Conductance and Röntgen Interference of Metallic Mixed Crystals. G. Tammann.** *Ann. d. Physik,* 1. 3. *pp.* 321–322, *Feb.* 9, 1929.

The author replies to the criticism by M. le Blanc, K. Richter and E. Schiebold [see preceding Abstract] and maintains his standpoint, which cannot be explained without minute detail. He objects that his critics had not studied the attack of pure gold. H. B.

**2309. Chain Reactions. M. Bodenstein.** *Preuss. Akad. Wiss. Berlin, Ber.* 29. *pp.* 490–497, 1928.

Various examples of chain reactions were explained and discussed.

The examples include the formation of hydrochloric acid, decomposition of nitrogen pentoxide, decomposition of chlorine monoxide and the use of antiknock reagents in the fuel for internal combustion engines. It was pointed out that investigations on the kinetics of such linked reactions are required in order to obtain more information on these reactions and to clear up the lack of equivalence between the absorbed quanta and the molecules altered, which is found in a series of photochemical reactions. F. J. B.

**2310. Platinising Glass and Other Substances. G. F. Taylor.** *J.O.S.A. and R.S.I.* 18. *pp.* 138–142, *Feb.*, 1929.

Materials required are: dry crystalline $PtCl_4$, oil of rosemary and oil of lavender flowers. The procedure recommended is as follows: an amount of oil of rosemary about twice as great by volume as the thoroughly dry platinic chloride is poured on to it, the mixture is crushed until no lumps remain and the resulting black mass has the consistency of thick paint, and it is then allowed to stand about an hour. At this point one or two courses may be followed according as to whether the solution is to be used simply for preparing glass to receive solder, when three times the volume of oil of lavender is thoroughly admixed, or the above black mass is poured into the tube of a centrifuge and absolute alcohol added to fill up the tube, when, after 5 or 10 minutes running, pale yellow crystals will appear, which are dissolved in oil of lavender in amount depending on the concentration desired. Details of application in both cases are included, and it is also shown how very neat resistance units can be made by depositing the film on glass. H. H. Ho.

**2311. Lattice Energies and Photochemical Decomposition of the Silver Halides. S. E. Sheppard and W. Vanselow.** *J. Phys. Chem.* 33. *pp.* 250–273, *Feb.*, 1929.

This paper records an investigation of certain of the energy changes in the decomposition of the silver halides in terms of the lattice energies of the crystals, since it affords a definite analysis of the steps involved in proceeding from silver and halogen to form silver halide crystals and conversely from these crystals to metallic silver and free halogen. The various sections deal with the subject as follows: thermochemical cycle for calculation of lattice energies of silver halides; ionisation work of silver; dissociation heats of halogens; heat of sublimation of silver; heats of vaporisation of bromine and of sublimation of iodine; heats of formation of silver halides; determination of lattice energies from electrostatic theory; relation of lattice energy to photochemical change; lattice disorientation and ionic deformation; internal disorientation and photoconductance; energy of activation and photochemical decomposition of silver halides; photoelectric effects; and orientation at interfaces and the photoelectric effect. It is concluded that the photochemical reactions of solids are assimilable to photochemical reactions of gases adsorbed to solids. H. H. Ho.

**2312. Photosynthesis of Naturally Occurring Compounds. E. C. C. Baly and N. R. Hood.** *Roy. Soc., Proc.* 122. *pp.* 393–398, *Feb.* 4, 1929.

In the irradiation of carbon dioxide with visible light in presence of finely-divided nickel carbonate suspended in water, the yield of carbohydrates is found to increase linearly with temperature in the range from 5° to 31° C. and, above this temperature, the yield decreases rapidly. The carbohydrates estimated are soluble in methyl alcohol and similar in all their properties to the products obtained by the action of ultraviolet light on formaldehyde in aqueous solution. The products have been definitely shown to contain glucose and fructose, while their nature seems to depend on the hydrogen-ion concentration during photosynthesis. The optimum temperature agrees closely with that at which maximum assimilation of carbon dioxide by plants has been found to occur. The upper and lower limits of temperature beyond which reaction ceases in the two processes also agrees approximately. The observations give support to the view that the complete activation of the carbon dioxide is achieved in two stages, namely, partial activation by adsorption on the surface of the catalyst and a second activation by the action of visible light on the adsorbed layer. [See Abstracts 212–214 (1928).] J. N. P.

**2313. Photosynthesis of Hydrochloric Acid. G. K. Rollefson.** *Am. Chem. Soc., J.* 51. *pp.* 770–778, *March*, 1929.

The photosynthesis of hydrochloric acid has been studied at low pressures with excess chlorine and has been found to follow the rate law

$$\frac{d(\mathrm{HCl})}{dt} = kI_0(\mathrm{H_2})(\mathrm{Cl_2}).$$

From these experiments and the work of other observers it is concluded that the action of light on this reaction is to form chlorine atoms in the $^2P_1$ state which serve as the starting point for the reaction chain. A mechanism is formulated which accounts for the action of water in this system and is in accord with the observed rate equations. AUTHOR.

**2314. Influence of Curvature of Solids on Chemical and Electrolytic Phenomena. L. R. Luce.** *Ann. de Physique*, 11. *pp.* 167–251, *Feb.*, 1929.

The influence of the curvature of solids on the velocity of attack was observed by Reboul in 1913. These early observations were limited to the attack by gases, and the work was continued to liquids. It was found that the phenomenon is a very general one. The attack of silver and copper by hydrogen sulphide or halogens, which cause coloured films, were studied by the method of Fizeau. Deposits of salts were formed, which showed the same succession of colours as Newton's rings. In the case of metallic wires or cones it was found that the formula $a = b/2R + c$ expressed the relative thickness of deposit $q$ on a radius of curvature R. A theoretical explanation of the phenomenon is attempted. F. J. B.

**2315. Acid Catalysis in Hydrolytic Reactions. J. N. Brönsted and W. F. K. Wynne-Jones.** *Faraday Soc., Trans.* 25. *pp.* 59–76, *Feb.*, 1929.

The conception of an acid or base as a substance with a tendency to dissociate or associate protons leads to the extended theory of catalysis which ascribes catalytic activity to acid or base molecules in general and not solely to the hydrogen or hydroxyl ions. It is shown that there is no *a priori* reason for excluding hydrolytic reactions from the scope of this theory, although there is the possibility of the effects escaping detection. In the hydrolyses of acetal and of ethyl orthoformate, catalysis by acids other than the hydrogen ion is undetectable. This circumstance renders the reactions suitable for the determination of hydrogen-ion concentrations and the study of salt effects. Hydrolyses of ethyl orthoacetate, orthopropionate and orthocarbonate show catalysis by the molecules of water, meta- and para-nitrophenols, cacodylic and acetic acids in addition to the hydrogen ion. The activities of the various catalysts are found to be dependent on their strengths as acids. Data are given for various reactions in different buffer solutions, and from these the dissociation constants of the acids are calculated. These results furnish definite evidence of the catalytic effects of uncharged acid molecules and, in conjunction with earlier results on the decomposition of nitramide and the mutarotation of glucose, strongly support the extended theory of catalysis. T. H. P.

**2316. Inflammation of Olefin-Air Mixtures in a Closed Spherical Vessel. G. B. Maxwell and R. V. Wheeler.** *Chem. Soc., J. pp.* 245–251, *Feb.*, 1929.

Further experiments [see Abstract 138 (1928)] are made with mixtures of air and the olefins ethylene, propylene, butylene, in a 4-litre sphere of bronze, highly polished inside, and with secondary spark ignition in the centre of the sphere. As in the case of the paraffins, the theoretical percentage for complete combustion is lower than the percentage for the maximum observed pressure (6·53 against 8·25 % in the case of ethylene), and the latter maximum is displaced towards the excess of hydrocarbon; this displacement is ascribed to dissociation. Further, the observed maximum pressure is lower than the theoretical maximum (8·15 against 9·42). This pressure loss was previously attributed to the, possibly too low, value of the specific heat of steam of Bjerrum; but increased heat loss by radiation at the higher temperatures is now considered the more probable explanation. The maximum-speed mixtures (of shortest interval between ignition and maximum pressure) correspond to the maximum-temperature mixtures. The main controlling factor in the development of pressure would then be the temperature of the flame, and that agrees with unpublished experiments of Georgeson and Hartwell on the speed of the uniform flame movement in olefin-air mixtures. H. B.

**2317. Combustion of Well-Dried Carbon Monoxide and Oxygen Mixtures. W. A. Bone, F. R. Weston and D. A. Winter.** *Roy. Soc., Proc.* 123. *pp.* 285–291, *March* 6, 1929.

In Part III further experiments are described, in which mixtures of the very pure gases with a little nitrogen were kept in glass explosion bulbs, containing redistilled and purified phosphoric anhydride, for periods which varied between 550 and 1000 days, while in previous experiments periods of 170 to 220 days only were employed. At the end of the drying period discharge sparks from a condenser of small capacity at 1000 volts were passed between the bulb electrodes. In each case a preliminary spark of considerable intensity was passed without producing ignition, but a still stronger spark caused explosion. There is practically no difference between these results and those of the previous experiments. The percentage combustion varied from 89·25 to 84·1. H. N. A.

**2318. Intermediate Compound Theory of Catalysis in Gas Reactions. H. H. Storch.** *J. Phys. Chem.* 33. *pp.* 456–458, *March*, 1929.

In several of the collision theories proposed to explain the mechanism of unimolecular reactions, activation by use of some of the internal energy of the molecule, in addition to the energy obtained by collision, was postulated [see Abstract 2017 (1928)]. In this paper the intermediate compound theory of catalysis is extended so as to present a theory of the function of these compounds in gas-phase catalysis. This function is to provide a complex (containing the reactant and the catalyst), of a sufficiently large number of degrees of freedom so that the energy of these may be available for contribution to the energy of activation. H. H. Ho.

**2319. Equilibrium in the System Methyl Alcohol-Hydrogen-Carbonic Oxide. D. M. Newitt, B. J. Byrne, H. W. Strong.** *Roy. Soc., Proc.* 123. *pp.* 236–252, *March* 6, 1929.

The equilibrium conditions of the system methyl alcohol-hydrogen-carbonic oxide were determined over a temperature range 280° to 340° C., and at pressures up to 100 atmospheres. The range of temperature was that at which the commercial production of pure methyl alcohol from water gas is possible. Two independent methods were employed for determining the equilibrium constant for the system $CH_3OH-CO-H_2$, and the results showed a fair agreement. When plotted against absolute temperature smooth curves were obtained which rose steeply at 290° C. A basic zinc chromate was used as a catalyst throughout all the experiments. The methyl alcohol was determined by conversion into nitrite and causing it to liberate iodine from KI solution. The iodine was then titrated with sodium thiosulphate. The various sources of error in the experimental methods employed were discussed. F. J. B.

**2320. Chemical Interaction of Ions and the "Clean Up" of Gases at Glass Surfaces under the Influence of Electrical Discharge. J. Taylor.** *Roy. Soc., Proc.* 123. *pp.* 252–270, *March* 6, 1929.

The disappearance of gas in the electric discharge was examined. The gas was contained in a soda-glass tube and was connected to a vacuum pump and gauge. The tube was arranged so that a portion could be immersed in baths of sodium nitrate maintained at suitable temperatures. It was found that a current usually passed through the walls of the tube, and that the gas progressively disappeared. The quantity of gas that disappeared was directly proportional to the quantity of electricity transferred across the glass walls for hydrogen, oxygen and nitrogen, but not for helium. The previous treatment of the glass affected the results, but on the whole the laws followed were of a similar nature to Faraday's law of electrolysis. No evidence was found in support of the theory that the disappearance of the gas was due to diffusion through the glass walls or to occlusion due to ions being driven with high velocity into the surface. F. J. B.

**2321. Decomposition of Nitrous Oxide in the Silent Electric Discharge. Parts II and III. S. S. Joshi.** *Faraday Soc., Trans.* 25. *pp.* 108–128, *March*, 1929.

These two papers refer to the earlier work by the present author [see Abstracts 2179 and 3006 (1927)]. The experiments carried out according to these two papers were in order to determine the applicability of the equation derived in the former work to the initial stages of the decomposition of nitrous oxide in the discharge. J. K.

**2322. Kinetics of the Hydrogenation of Ethylene at a Copper Catalyst of Known Area. F. H. Constable.** *Zeits. f. Elektrochem.* 35. *pp.* 105–110, *March*, 1929.

The modified Pease apparatus used comprised a furnace in which the copper is reduced by hydrogen from granulated copper oxide. The ethylene is kept cool by liquid air and finally distilled into an aspirator containing water, free of air, in a hydrogen atmosphere. The area of the copper is estimated by the interference method of the author [see Abstract 2680 (1928)], which cannot determine surface inequalities of less than $10^{-5}$ cm. The deduced equation is very satisfactory as to time and concentration. But the ratios of hydrogen and ethylene adsorbed (the latter always much more than the former) and the activity change with each separate experiment. The maximum rate of the hydrogenation was observed at 0° C. in a vapour mixture containing 18 % of ethylene (rest hydrogen), at 100° C. with 42 % of ethylene and at 200° in equimolecular mixtures. Experiments at constant pressure, so far 80 cm., are proceeding. The hydrogen adsorbed by the catalyst surface of $9 \cdot 6 \times 10^3$ cm.$^2$ should be sufficient for a monomolecular film; but part of the surface must have been free of hydrogen even at 0° C. H. B.

**2323. Topochemistry of Contact Catalysis. G. M. Schwab and E. Pietsch.** *Zeits. f. Elektrochem.* 35. *pp.* 135–141, *March*, 1929.

In heterogeneous gas reactions the seat of the gas reaction is in the layer of molecules or atoms adsorbed by the catalyst, while the gas phase serves as reservoir for replenishing this layer. The assumption of a homogeneous monomolecular layer (Langmuir) is quantitatively incompatible with the heat liberation, the poisoning of the catalyst and the influence of additional constituents in it. H. S. Taylor [see Abstract 1768 (1925)] suggested that a number of extra lattice atoms, of unsaturated character, projected from the surface, and that these atoms formed the centres of the reactions. Felman and Adhikari observed that a jet of iodine molecules, hitting one side of a suspended drop of mercury, would be adsorbed all over the surface of the drops, but would not form $HgI_2$, unless the opposite side was touched with a crystal of $HgI_2$. This and other experiments by Volmer and Adhikari [see Abstract 1925 (1926)] indicate that the reaction takes place along boundary lines (not surfaces), *e.g.*, crystal edges and grain boundaries (Cassel). The authors develop this theory mathematically and show that it would hold both for the Langmuir layer and when the reaction is three-dimensional, by impact of the particles from the gas outside with the particles of the two-dimensional layer according to the kinetics of impact reactions of Hertz and Knudsen. Thus the active centres would in general be lines homogeneous in themselves. H. B.

**2324. Oxidation of Copper at High Temperatures. W. Feitknecht.** *Zeits. f. Elektrochem.* 35. *pp.* 142–151, *March*, 1929.

Copper foil, 1 mm. thick, is heated in a $CO_2$ atmosphere to the desired temperature, and oxygen or nitrogen-oxygen mixture is then introduced. There is always a slight oxidation already in the $CO_2$. The subsequent oxidation does not exactly follow the parabolic law $x^2 = kt$ (where $x$ is the increase in weight), nor is the constant K strictly given by $K = A \, . \, e \, . \, ^{-E/RT}$ [see Dunn, Abstract 2219 (1926)]; a constant K variable with the thickness of the oxidation layer had been proposed by Tammann. The rate of oxidation is too great in the initial stages, and the K diminishes less quickly afterwards than assumed. The oxidation layer consists always essentially of cuprous oxide, over which a thin film of oxide may spread; photographs of the appearance of the oxide films at temperatures up to 1020° are given. The reason of the deviation from regular laws is that the diffusion of the oxygen through the film formed takes place both through the crystallites of the cuprous oxide and along the grain boundaries; the size of the crystals is small at low and falling temperatures. The formation of cupric oxide is very slow, but more rapid at mean temperatures (750° to 850°) than at higher or lower temperatures. H. B.

**2325. Photovoltaic Cells with Silver-Silver Bromide Electrodes. Part I. W. Vanselow and S. E. Sheppard.** *J. Phys. Chem.* 33. *pp.* 331–353, *March*, 1929.

The behaviour of photovoltaic cells consisting of silver-silver bromide electrodes in solutions of potassium bromide is studied. The p.d.-time curve obtained is the resultant of two effects, *viz.*, an initial negative effect on which is superimposed a positive effect. The phenomenon is explained by the hypothesis developed to explain these effects in terms of the liberation of electrons and bromine atoms from bromide ions on the absorption of light. This view is supported by the fact that the positive effect could be suppressed and the negative effect made more pronounced by the addition of bromine acceptors. The positive effect is shown to be similar to that produced by allowing bromine to diffuse through the AgBr layer to the silver. F. J. B.

**2326. Single Potential of the Copper Electrode. E. Newbery.** *Am. Chem. Soc., J.* 51. *pp.* 1315–1322, *May*, 1929.

The possible causes of irregularity in determining the electrode potential of copper are discussed, and it is shown that the nature of the surface has no effect (save as regards speed of reaction), and that while presence of hydrogen in the copper and instability of the electrolyte have a slight effect, by far the chief cause is the interaction between the electrolyte and electrode, a film of basic salt being very rapidly formed. After trying various methods to avoid this, a purely mechanical one, whereby, using the cell Cu | $M/_2CuSO_4$ | $Hg_2SO_4$ | Hg at 20° C., the potential was measured immediately after the cleaned electrode was immersed in the electroyte, was found to give the figure $0 \cdot 3630 \pm 0 \cdot 0005$ V. A two-phase copper amalgam in place of pure copper gave $0 \cdot 3633 \pm 0 \cdot 0003$ V, showing that the presence of mercury had no effect. A repetition of Nielsen and Brown's method [see Abstract 494 (1928)] at 25° ± 0·02° gave 0·3596 as compared with their figure of 0·3592. C. A. S.

**2327. Potential of the Nickel Electrode. M. M. Haring and E. G. V. Bosche.** *J. Phys. Chem.* 33. *pp.* 161–178, *Feb.*, 1929.

The potential of nickel is measured by means of the cell

$$Ni/NiSO_4/Hg_2SO_4/Hg$$

which involves no liquid junction. The nickel is prepared by electrolysis at high current densities. It is found necessary to exclude hydrogen and oxygen during the potential measurements. Cobalt is shown to be either more positive than nickel or less polarised. Nickel chloride, due to hydrolysis, is found to be an unsatisfactory electrolyte in potential measurements. The activities of the nickel sulphate solutions are taken as the same as the known values for copper sulphate solutions. On this basis, and taking the standard hydrogen electrode as zero, values for the standard potential E*o* of nickel, or the potential for a solution containing the ion at unit activity, from measurements at different concentrations, give the identical value of $- 0 \cdot 231 \pm 0 \cdot 002$ volt at 25° C. This corresponds to about $- 0 \cdot 245$ volt for the normal potential. J. N. P.

**2328. Output in Nickel Plating with High Current Density. Influence of Oxidising Agents and Concentration of Hydrogen Ions. Ballay.** *Comptes Rendus*, 188. *pp.* 556–559, *Feb.* 18, 1929.

Nickel plating can now be carried out with 8 to 15 amperes per square decimetre, by adding a small amount of oxidising material to the bath. The author investigated the effect of different proportions of oxidising agent, and of the concentration of hydrogen ions, and found that the addition of a small amount of nickel nitrate slightly diminished the amount of nickel deposited on the kathode, which, however, was 95·4 % of that calculated from Faraday's law; a good deposit was obtained. An increase in the amount of nitrate diminished the efficiency rapidly, and after a certain point gave a yellowish, cracked deposit. Permanganate of potash gave similar results, but the action was not so intense, though the efficiency with the optimum dose was somewhat greater. It was found that with the added nitrate of nickel a change in $p$H from 4·4 to 6·8 did not greatly affect the output in deposited nickel, but that for $p\text{H} > 5{\cdot}5$ the deposit was weak and cracked. H. N. A.

**2329. Electrolytic Solution Forces and the Electrolytic Ionic State. K. Fredenhagen.** *Zeits. f. phys. Chem.* 140. *Abt. A.* 5–6. *pp.* 435–474, *Feb.*, 1929.

The earlier papers by the author on the same subject are summarised [see Abstract 2539 (1928)]. The electrolytic distribution number is shown to be a measure of the electrolytic solution forces which are exerted by the solvent upon the neutral atoms, which form the ions in the solution. The electrolytic solution forces were shown to depend upon the state of the solvent, *i.e.*, the magnitude of the van der Waals cohesion force, and upon the affinity of the solute for the binary dissociation products of the solvent. The bearing of the electrolytic solution forces on electrolytic dissociation is discussed, and the mechanism of electrolytic dissociation is described in a graphic representation. F. J. B.

**2330. Thermodynamic Activities of the Proteins. G. S. Adair.** *Am. Chem. Soc., J.* 51. *pp.* 695–707, *March*, 1929.

The author derives formulæ correlating the thermodynamic activities of protein salts with osmotic pressure data and applies these formulæ to a salt of hæmoglobin, for example, sodium hæmoglobinate, $\text{HbNa}_n$, where $n$ represents the average number of sodium atoms combined with the protein molecule and may have an average value ranging from 0 to 80 in accordance with variations in the activities of sodium and hydroxyl ions. $n$ is neither an integer nor a constant independent of the concentrations of the diffusible electrolytes. Under certain conditions the salt of a protein such as sodium hæmoglobinate is equivalent to one component, but really sodium hæmoglobinate is a mixture of a great number of individual salts. [See Abstract 625 (1929).] J. K.